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Crossroads: Climate risks and biodiversity in Finland

Analysis of awareness of climate risks and cross-sectoral impact chains, and coordination across sectors

Anna Katariina Lipsanen

Master Thesis

Supervisor: Anne Gravsholt Busck

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Author:	Anna Katariina Lipsanen
Title:	Crossroads: Climate risks and biodiversity in Finland Analysis of awareness of climate risks and cross-sectoral impact chains, and coordination across sectors
Supervisor:	Anne Gravsholt Busck
Name of department:	Department of Geosciences and Natural Resource Management
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Cover photo:	Arctic fox, pixabay.com. The Arctic fox is critically endangered in Finland

"We share with other species a common relationship to the Earth."

- Taylor (1981, p. 207)

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Abstract

This thesis aims to analyse the awareness of climate risks and cross-sectoral impact chains related to biodiversity, and to examine coordination across sectors and actors. By conducting a thematic analysis, the objective of this thesis is to analyse how aware are different sectors of climate risks related to biodiversity and what direct and indirect climate risks and impact chains regarding biodiversity are identified. Moreover, the thesis examines how the actors are coordinating in climate change adaptation and biodiversity related matters and what are the key coordination challenges and opportunities. Focus-group interviews with administrations and regional stakeholder workshops as well as conducting a literature review are used as methods for this study. Main findings indicate that even though indirect risks relating to biodiversity were identified, in general, the actors from all sectors are identifying and focusing on the direct risks of climate change within sectors and grasping issues concerning indirect risks is perceived as difficult and complex. Cross-sectoral coordination related to biodiversity has challenges mostly relating to conflicting values and interests, knowledge and information exchange and assignment of responsibilities, but also opportunities and synergies with adaptation were found, especially in land use solutions. However, further identification of complex cross-sectoral impact chains and indirect risks to biodiversity as well as finding synergies with biodiversity and adaptation measures are required.

List of abbreviations

AR5	The IPCC 5th Assessment Report
EEA	European Environment Agency
EU	European Union
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
MRE	Monitoring, reporting and evaluation
NAP	National adaptation plan
NAS	National adaptation strategy
NGO	Non-governmental organisation
RCP	Representative Concentration Pathways
SYKE	Finnish Environment Institute
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

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1 Introduction

Adaptation to climate change is coming increasingly important from humanitarian and economic points of view as there is compelling evidence, that climate change will have economic, social and cultural implications on both human and natural systems, and to several sectors and levels of society (Brown, 2018; Huitema et al., 2011; IPCC, 2014a; IPCC, 2013; IPCC, 2018b; Sanderson et al., 2018). Already occurring extreme weather events call for adaptation actions at the present climate (IPCC, 2014a; IPCC, 2018b). Furthermore, according to IPCC (2018b) limiting global warming to 1.5˚C requires major and immediate emission reductions and societal transformations as well as multilevel and cross-sectoral measures from both climate change mitigation and adaptation. Adoption of the Paris Agreement in 2015 set the stage for further mitigation and adaptation actions (United Nations, 2015), but its ambitious goals require significant efforts from all Parties to tackle climate change (Falkner, 2016; Savaresi, 2016).

Biodiversity and ecosystems are facing major risks from climate change and there is a consensus among scholars that climate change over the coming century will increase the risk of extinction for many species (IPBES, 2018; IPCC, 2014b; Nogués-Bravo et al., 2018). Already at present, both marine and terrestrial populations are in decline worldwide, and extinction events are experienced across all trophic levels and ecosystems. These extinction events can have cascading effects on all ecosystems and threaten health and livelihoods of people as well since humans heavily depend on the services that biological diversity provides (IPBES, 2018; Laurila-Pant et al., 2015; Nogués-Bravo et al., 2018). The impacts and risks from climate change to biodiversity and human systems are also expected to increase in proportion to the magnitude of climate change (IPBES, 2018; IPCC, 2014a; Nogués-Bravo et al., 2018). However, measuring, predicting and mitigating this biodiversity change and its consequences is one of the greatest challenges facing scientists and society today (IPBES, 2018; Laurila-Pant et al., 2015; Naeem et al., 2016).

Moreover, climate change has been labelled as a wicked (Huitema et al., 2011, p. 179) or even a super wicked problem (Levin et al., 2012, p. 123) based on the characteristics of a particularly complex social policy problem identified by Rittel & Webber (1973). It is also a cross-cutting and multi-level problem that involves long timescales and uncertainties (Brown, 2018; Huitema et al., 2011; IPCC, 2014a). These complex interactions and changing likelihoods involved in

climate change bring about impacts that appear either directly or indirectly through cross-sectoral impact chains (IPCC, 2014a).

According to IPCC, when addressing the potential climate change impacts, focus on risks supports decision making in the context of climate change (IPCC, 2014a). A risk-based structure can provide considerable scope to unify knowledge and deliver coherent climate change policy responses. Policy-making objectives in general are often strongly associated with risk management, hence explicit characterization of risks to policy outcomes can provide direct interface with decision-making processes. Risk assessment as a structured procedure can also provide consistency when identifying priorities for adaptation (Brown, 2018). Furthermore, the characteristics of climate change risks imply a need for an integrated multisectoral approach to manage direct and indirect risks (Heltberg et al., 2009). Moreover, according to Brown (2018), the knowledge on indirect risks remains an important barrier to further development of cross-sectoral adaptation policy. However, the indirect risks caused by weather and climate hazards are more difficult to assess and often to manage as well and there is a need to further study the indirect, cross-sectoral risks of climate change also in Finland (Tuomenvirta et al., 2018).

The cross-cutting and multi-level characteristics of climate change have been raising awareness about the importance to treat it as a cross-sectoral problem instead of limiting it to the environmental sector. Including governmental and non-governmental actors in the policy making processes is also essential. Furthermore, coordination between actors and administrative sectors is needed in order to successfully implement adaptation measures in the everyday planning and activities of various sectors (Christensen & Lægreid, 2019; Juhola & Westerhoff, 2011; EEA, 2015).

The objective of this thesis is to analyse direct climate risks to biodiversity as well as to identify some of the indirect climate risks and cross-sectoral impact chains related to biodiversity in Finland. Moreover, it analyses how coordination between actors and administration levels to manage these risks is organised. The thesis seeks to answer the following research questions:

1) What is the awareness of direct and indirect climate risks related to biodiversity in Finland?
    a. What direct climate risks to biodiversity have been identified in Finland?

b. What indirect climate risks and cross-sectoral impact chains related to biodiversity have been identified in Finland?
c. How aware are public administration actors and other key stakeholders of climate risks related to biodiversity?

2) How is cross-sectoral coordination organised in climate change adaptation and biodiversity related matters in selected sectors in Finland?
    a. What challenges and opportunities for coordination have been identified?

The first research question aims to analyse the awareness of climate risks and to identify the direct and indirect risks and cross-sectoral impact chains related to biodiversity. The second research question addresses coordination across sectors and scales and aims to identify the coordination challenges and opportunities for climate risk management regarding biodiversity. This thesis was conducted as part of the mid-term evaluation process of Finland's National Climate Change Adaptation Plan 2022 (NAP)[1]. As material for this study, data gathered in the mid-term evaluation process of the NAP is used along with a review on relevant literature. The mid-term evaluation process is further described in section 2.4.2.

Different climate risks

To understand the climate impacts and risks addressed in the context of this thesis, it is important to acknowledge what is meant by these terms. Section 4.1 goes into more details of the climate impact and risk terminology, but a brief explanation of different risks is given here.

Climate change can bring about *direct, indirect* and *transnational*[2] impacts and risks[3]. Direct impacts and risks to natural and human systems actualise through changes in the present climate (IPCC, 2014b; IPCC, 2018a). *Indirectly* appearing risks are risks to a certain sector that realise through changes in other sectors. These are more complex than direct risks and their impact

[1] Finland's National Climate Change Adaptation Plan 2022 is referred to as NAP in this thesis.

[2] The terminology that refers to the international dimension of climate change impacts and risks is not consistent. See (Benzie et al., 2019) for more details.

[3] In this thesis the term *risk* is used to refer to the direct or indirect *climate related* risks.

chains are not always easy to demonstrate (Brown, 2018). The term 'indirect' is used in this thesis to describe the cross-sectoral aspect of climate risks. Furthermore, in a globalised world, where daily cross-border flows of finance, goods, resources and people are an everyday action, the impacts of climate change are likely to be felt across borders as well (Benzie et al., 2019). These *transnational* impacts affect one country – and require adaptation there – as a result of climate change or climate-induced extreme events in another country (Hedlund et al., 2018; IPCC, 2018a).

This thesis focuses on the direct and indirect risks and impact chains of climate change in Finland. The direct impacts and risks from climate change are relatively well identified in Finland, thus recent literature is used here to demonstrate the direct risks to biodiversity (Ministry of the Environment, 2016a; Tuomenvirta et al., 2018). The empirical material is used to identify the indirect, cross-sectoral aspects of climate risks related to biodiversity.

Sectors selected for the study

This study reflects on several sectors to gain a comprehensive view of the indirect risks and cross-sectoral impact chains related to biodiversity as well as to be able to examine coordination between sectors and actors. However, as indirect climate impacts and risks can span across multiple sectors, the search is limited to the following sectors: built environment, transport, water resources management, energy, health and natural resources (including agriculture, forestry, fisheries, reindeer husbandry and game industry). The sector selection is based on the administration interviews and stakeholder workshops gathered during the mid-term evaluation process of Finland's NAP further explained in section 3.2.

2 Background

This chapter gives a brief background to this study by giving an overview of climate change impacts in Finland, identifying the linkages between climate change and biodiversity, describing the key terms related to adaptation and presenting Finland's adaptation policy framework.

2.1 Overview of climate change impacts in Finland

Climate change pathways for Finland

Finland is expected to face consequences from climate change. Even though Finland is relatively safe from the most negative impacts of climate change, the risks of a changing climate must be identified in Finland as well. The magnitude of the impacts is still uncertain, and depends on global pathways and scenarios (Ministry of Agriculture and Forestry, 2014; Ruosteenoja et al., 2016). To indicate these pathways, the international science community has introduced four different Representative Concentration Pathways (RCP) to show how climate change may proceed (IPCC, 2013). The pathways (from lowest to highest, RCP2.6, RCP4.5, RCP6.0 and RCP8.5) are founded on different assumptions on the trend in the warming impact of anthropogenic greenhouse gases and fine particles (i.e. radiative forcing[4]) by the end of the century (IPCC, 2013; Ministry of Agriculture and Forestry, 2014).

The pathways are not forecasts but they reflect the broad spectrum of the potential changes in the climate. The scenarios still involve a great deal of uncertainty. For instance, the causes for uncertainties include shortcomings in the knowledge base, such as deficient data and shortcomings in the climate models, and unforeseeable changes in human behaviour and the economy. Moreover, the most serious risks associated with climate change in different sectors and regions evolve as the global mean temperature rises (IPCC, 2014a; Ministry of Agriculture and Forestry, 2014).

[4] Radiative forcing or climate forcing is a measure of the influence a particular factor (e.g. greenhouse gases, aerosol, clouds) has on the net change in the energy balance of the Earth. Positive radiative forcing leads to warming and negative to cooling of the climate (IPCC, 2013).

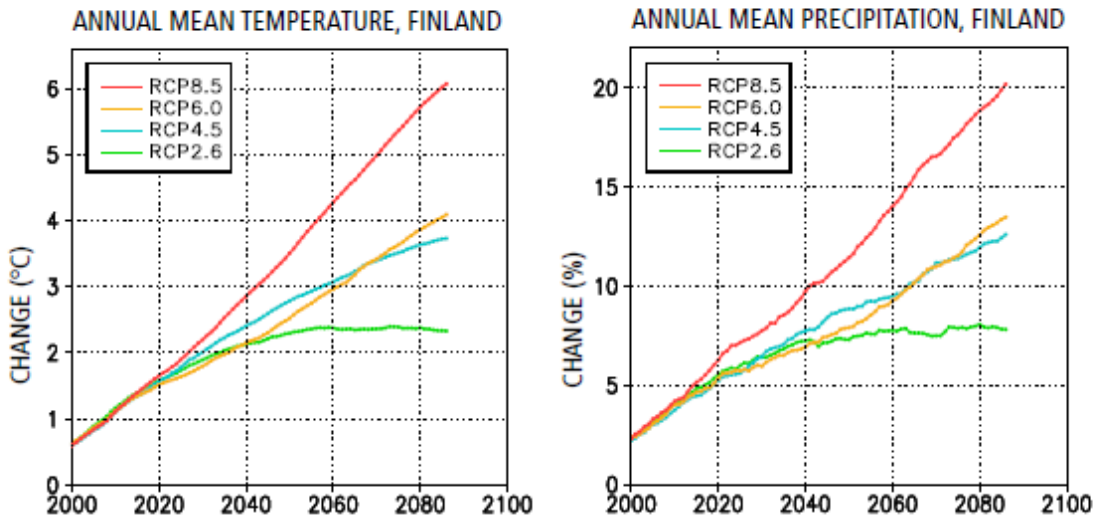

Figure 1. Change in the annual mean temperature (°C) and precipitation (%) in Finland in 2000-2085 compared to the average values in 1971–2000. The lines indicate the average of the results of 28 global climate change models for the four different Representative Concentration Pathways (RCPs) (Ministry of Agriculture and Forestry, 2014, p. 11).

Based on the RCP scenarios, the temperature in Finland is projected to rise by 2.3 to 6 degrees C° by the end of the century compared to the period 1986–2005, depending on the global trend in greenhouse gas emissions (Figure 1). The RCPs show, that adaptation is a necessity even if a clear decrease was achieved in the greenhouse gas emissions on the global scale since the change in the atmosphere already taken place causes changes in the climate system and, very likely, further global warming at least by about one degree and lead to e.g. sea level rise (Ministry of Agriculture and Forestry, 2014). Furthermore, warming near the pole is much faster than the global average, making the impacts of precipitation and rise in average mean temperature more intense (IPCC, 2014a; Ministry of Agriculture and Forestry, 2014).

Main climate change impacts for Finland

The major expected climate change impacts in Finland include the rise in average mean temperature, increasing amount of precipitation and shorter snow cover periods (Ministry of Agriculture and Forestry, 2014). The average temperature in Finland will rise more and faster than the global average. It is expected that far below-zero temperatures will become rarer, very warm periods will become more common and maximum temperatures will increase. The winter temperatures in particular will rise and winters will become cloudier. Precipitation is projected to increase and during the winter, more of it comes as water instead of snow (Ruosteenoja et al., 2016). Heavy rains are increasing and the intensity of the rains is expected to grow. Snow cover period will become shorter and it will be thinner due to higher temperatures. There will be less

frost in the ground and the period when frost appears will be shorter. Also snow water equivalent will be more limited. Moreover, in mild winters the soil is wet and its carrying capacity is weaker due to high precipitation which increases the risk of floods. Even though no major changes are projected in windiness, strong winds are expected to appear more frequent and, for example, during the winter, strong winds may cause more trees to fall as there is less frost in the ground (Ministry of Agriculture and Forestry, 2014). Overall, the intensity of the changes in Finland's climate depends on the scenario (Ruosteenoja et al., 2016).

Both nature and societies will be faced with exceptionally rapid changes as climate warming proceeds, which means that adaptation is needed (Ministry of Agriculture and Forestry, 2014). For example, the increasing amount of storms and droughts Finland has had in recent years indicate, that the society and some of the infrastructure are vulnerable to extreme weather events.

2.2 Climate impacts and risks for biodiversity

2.2.1 The definition of biodiversity

Biological diversity or biodiversity often refers to the variety of life across genes, species and ecosystems. According to (Díaz et al., 2015), biodiversity refers to the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. This includes variation in genetic, phenotypic, phylogenetic and functional attributes, as well as changes in abundance and distribution over time and space within and among species, biological communities and ecosystems (Díaz et al., 2015). In this thesis, biodiversity refers to species and habitats occurring in Finland in terrestrial, aquatic and marine (the Baltic Sea) ecosystems.

2.2.2 Direct impacts and risks from climate change to biodiversity

Biodiversity and ecosystems are essential for all life by providing food, life-supporting atmospheric conditions, drinkable water, as well as raw materials for basic human needs. Moreover, they have a strong impact on the weather and climate itself, which in turn affects agriculture, food supplies, socioeconomic conditions and physical infrastructure. As ecosystems change, their capacity to supply these services changes as well, for better or for worse. As a result, human well-being is put at risk, along with the welfare of millions of other species. (IPCC, 2014a, p. 319).

According to Ceballos et al. (2017), the Earth is experiencing a huge number of population declines, and it is estimated that billions of vertebrate populations have disappeared during the last decades making the Earth on the verge of a sixth mass extinction wave. The resulting biological annihilation will have serious ecological, economic and social consequences as biodiversity and ecosystems are the foundation of human well-being and these losses of species and habitats cannot be disregarded (Ceballos & Ehrlich, 2018; Ceballos et al., 2017). The biodiversity crisis is strongly linked to climate change, but also to other aspects of global change such as land-use changes and invasive species, and consequently threatens health and livelihoods (Laurila-Pant et al., 2015; Nogués-Bravo et al., 2018). Furthermore, it has been observed that many plant and animal species have moved their ranges, altered their abundance, and shifted their seasonal activities in response to observed climate change over recent decades (IPCC, 2014a).

Climate change has both direct and indirect[5] impacts on biodiversity and there is clear evidence to show that ecosystems globally are already responding to climate change and will continue to do so (IPCC, 2014a; Nogués-Bravo et al., 2018). Direct impacts include changes e.g. in phenology (i.e. the timing of biological phenomena), species abundance and distribution, community composition, habitat structure and ranges, and in ecosystem processes. For instance, it takes a lot of time for the species to adapt to changing habitats, while alien species may sometimes adapt to new conditions quite rapidly (Naeem et al., 2016; Nogués-Bravo et al., 2018).

Climate change may also have impacts on other factors and disturbances that alter ecosystems, such as the increasing risk of forest fires and insect damages. These impacts are a result of various kinds of cause and effect chains. For example, increased precipitation may increase nutrient flows to waters and reduce the salinity of the Baltic Sea. The rise in the carbon dioxide levels in the atmosphere may also cause relatively small but still significant acidification of the sea water (Ministry of Agriculture and Forestry, 2014).

[5] Current knowledge of indirect impacts and risks related to biodiversity is further addressed at the end of section 5.2.1.

2.3 Climate change adaptation

To deal with the impacts and risks brought by climate change, adaptation is required. It is important to establish what adaptation in climate change context means thus this section provides a brief explanation of key terms related to adaptation. Assessing and managing risks are also relevant in adaptation context and they are further explained in section 4.1. The key terms in this section are written in italics.

Adaptation is the process of adjustment of human and natural systems to function in the present climate and prepare for expected climate and its effects. In human systems, adaptation aims to prevent or reduce the adverse impacts due to climate variability and change, and to take advantage of opportunities that may arise. In natural systems, human intervention may facilitate adjustment to expected climate and its effects. It has been shown that well planned, early adaptation actions save money and lives later (European Commission, 2019; IPCC, 2014a; IPCC, 2018a; Ministry of Agriculture and Forestry, 2014).

Adaptive capacity refers to the ability to design and implement effective adaptation strategies, or to react to evolving hazards and stresses. The adaptation process requires the capacity to learn from previous experiences to cope with current climate, and to apply these lessons to cope with future climate, including surprises. Adaptive capacity is generally high in many human systems, but implementation related to adaptation faces major constraints especially for transformational responses at local and community levels (Brooks & Adger, 2004; IPCC, 2014b).

Resilience is the conscious and proactive ability of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning and transformation (Arctic Council, 2013, p. viii; IPCC, 2014a, p. 5).

Examples of adaptation measures are, for instance, using scarce water resources more efficiently, adapting building codes to future climate conditions and extreme weather events, and building and enhancing flood defences. Also developing drought-tolerant crops, choosing tree species and forestry practices less vulnerable to storms and fires, and providing land corridors to help species migrate are important adaptation measures (European Commission, 2019; Ministry of Agriculture and Forestry, 2014).

2.4 Finland's adaptation policy framework

Adaptation has received growing attention in the international climate policy domain over the past years. As adaptation measures often require governmental steering, policy instruments for national adaptation have been established, such as NAPs (European Commission & European Environment Agency, 2019; UNFCCC, 2018).

The need to adapt to climate change was recognised in Finland in the early 2000s. Finland was the first EU country to publish a National Strategy for Adaptation to Climate Change (NAS) in 2005 (Ministry of Agriculture and Forestry, 2005). The UN and EU climate policies, such as the Paris Agreement and the EU Strategy on Adaptation to Climate Change, also provide a framework for adaptation policies in Finland (European Commission, 2013; European Commission, 2019; Ministry of the Environment & Statistics Finland, 2017).

Furthermore, the Climate Change Act entered into force on 1st of June 2015 in Finland (Climate Change Act, 2015). Through the Act, adaptation has been integrated into climate policy and the Act obliges the Government to adopt a national adaptation plan for climate change at least once every ten years. Furthermore, the adaptation plan implements the EU Strategy on Adaptation to Climate Change in Finland (European Commission, 2013; Ministry of Agriculture and Forestry, 2014). The NAP steers adaptation policies and is coordinated by the Ministry of Agriculture and Forestry. The key adaptation policies in Finland are summarised in Figure 2.

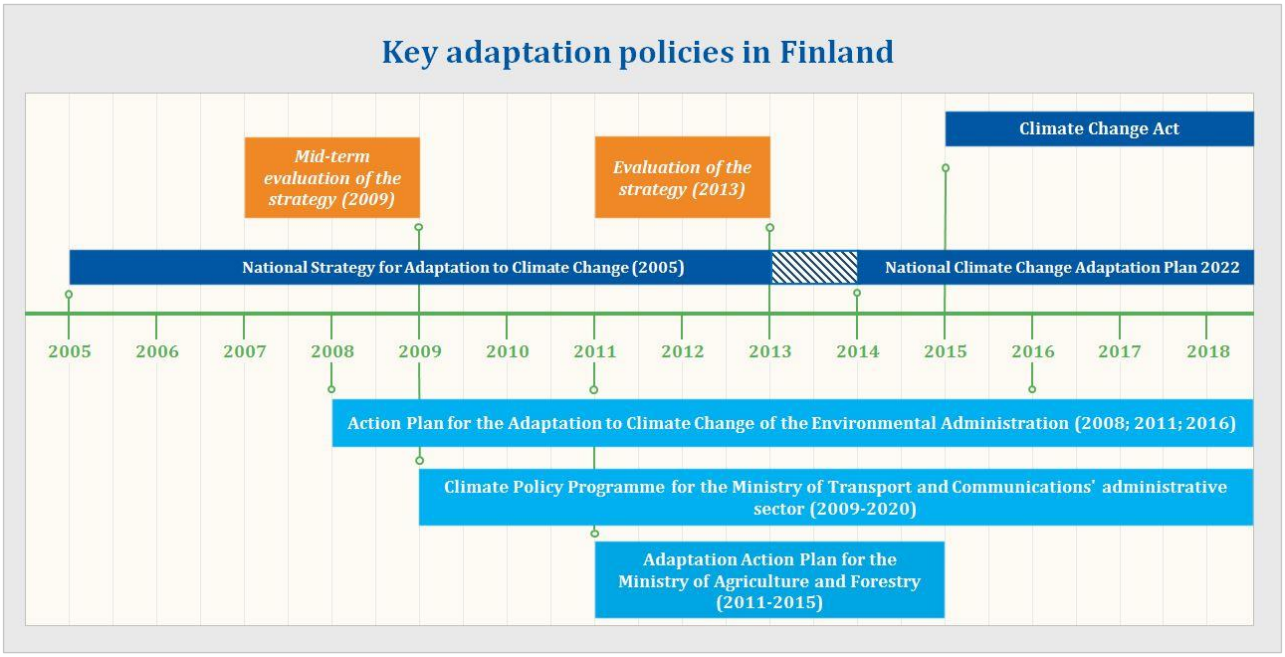

Figure 2. Key policy measures related to adaptation in Finland. The Climate Change Act and the national adaptation plan coordinated by the Ministry of Agriculture and Forestry steer the adaptation efforts of various ministries (figure adapted from Climateguide.fi, 2018b).

In addition to governmental steering, municipalities play an important role in adapting to climate change. They are in charge of e.g. land use planning and responsible for emergency response to natural disasters (Ministry of Agriculture and Forestry, 2014). Moreover, research and development related to adaptation is a key part in supporting adaptation policies in Finland. There have been several research projects related to adaptation, and new research themes are continuously emerging (Climateguide.fi, 2018a).

2.4.1 Finland's National Climate Change Adaptation Plan 2022

The National Climate Change Adaptation Plan (NAP) in Finland was published in 2014 as a Government Resolution[6] and follows the 2005 NAS. The focus of the NAS was at the national level and the approach was sector-based. The updated NAP, however, addresses adaptation from a more cross-cutting perspective while at the same taking into account the special characteristics and needs of individual sectors and regions in the planning and targeting of adaptation actions (Ministry of Agriculture and Forestry, 2014). The NAP encourages that *"Adaptation plans or*

[6] Government Resolution is a document issued by the Government of Finland, which gives instructions and guidelines to the state administration for preparing various political matters. Resolutions are mainly political statements and preparatory decisions that have no direct legal effect on citizens.

action programmes for specific administrative branches may further specify the measures to be taken in the branch to manage climate risks and reinforce the adaptive capacity" (Ministry of Agriculture and Forestry, 2014, p. 21). Furthermore, according to the Finnish Climate Change Act (Climate Change Act, 2015), the state authorities must, to the extent possible, promote the implementation of the adaptation plan in their actions. The Ministry of Agriculture and Forestry was responsible for the preparation of the National Climate Change Adaptation Plan, with the practical work steered by a broadly-based National Monitoring Group for Adaptation[7] appointed by the ministry (Ministry of Agriculture and Forestry, 2014).

The aim of the NAP is ”*that the Finnish society has the capacity to manage the risks associated with climate change and adapt to changes in the climate”* (Ministry of Agriculture and Forestry, 2014, p. 4). Its key objectives and fields of action are shown in Figure 3.

[7] In Finland, monitoring and evaluation of national adaptation policy is the responsibility of an inter-ministerial working group that brings together multiple sectors in implementation and evaluation of adaptation policy. The working group was first set up in 2008 to monitor and promote implementation of the NAS (2005) and to steer a national research programme on adaptation. In November 2014, the new NAP was approved and consequently a new working group was set up for 2015–2018 (National Monitoring Group for the National Adaptation Plan). The purpose of the current working group is to coordinate implementation of the new NAP in the public sector, with a specific mandate to monitor and report on the implementation of the NAP and promote evaluation of the effectiveness of adaptation measures. The working group has been instrumental in facilitating cross-sectoral coordination in Finland and in allowing for exchange of lessons learnt across sectors (EEA, 2015, p. 31).

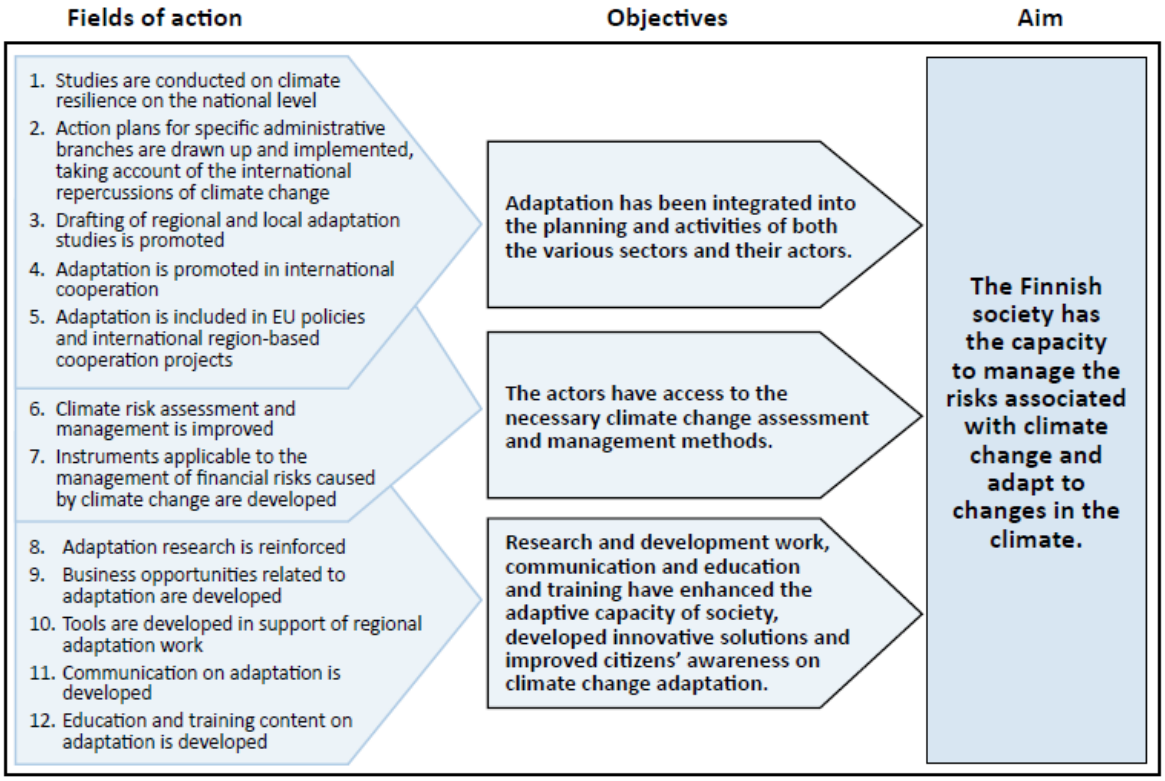

Figure 3. Key fields of action, objectives and aim of Finland's National Climate Change Adaptation Plan 2022 (Ministry of Agriculture and Forestry, 2014, p. 4)**.**

The objectives and measures of the NAP extend until the year 2022, but the aim extends far into the future. The international repercussions of climate change are also on the agenda in the national adaptation work (Ministry of Agriculture and Forestry, 2014).

The NAP states that mitigating greenhouse gas emissions on a global scale is of outmost importance to prevent and reduce the adverse impacts of climate change. However, the uncertainty associated with the magnitude or exact impacts of climate change should not be an obstacle to launching practical actions, and that the most cost-efficient way of implementing the adaptation actions is by integrating them into the planning, decision-making and activity of each of the relevant sectors. The cross-cutting elements of adaptation should be promoted by targeting the key steering instruments, especially legislation and financial steering. It is also key to prevent and mitigate climate risks and thereby reinforce the adaptive capacity. Furthermore, climate change must be taken into account in the mid- and long-term decision-making (Ministry of Agriculture and Forestry, 2014).

2.4.2 The mid-term evaluation process of the NAP

While creating new climate policies is essential to meet the ambitious climate goals both on national and global level, it is important for both academics and practitioners of climate policy to perform regular evaluations about the implementation phases of already existing policy instruments (Huitema et al., 2011). Monitoring, reporting and evaluation (MRE) also play a central role in identifying what is the best way to reduce vulnerability and build resilience to climate change (Bours et al., 2013). The tool presented in Figure 4 is based on the concept of a policy cycle, which highlights that climate change adaptation is an iterative process in which it is needed to ensure that decisions are based on up-to-date data and knowledge (EEA, 2015).

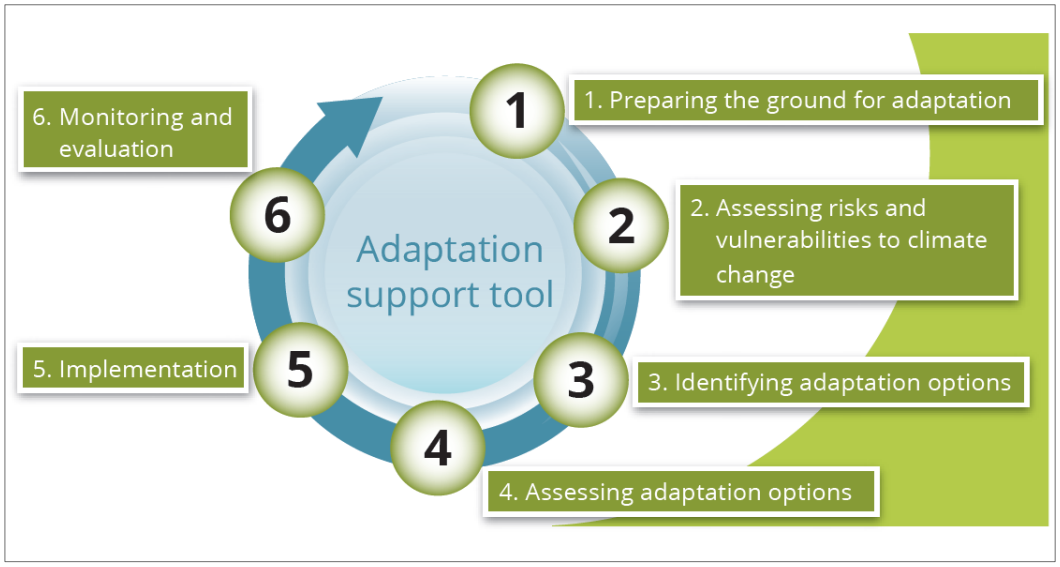

Figure 4. The European Adaptation Support Tool (EEA, 2015, p. 19).

In Finland, the mid-term evaluation of the NAS was done in 2009 and more comprehensive evaluation for the review of the strategy was conducted in 2012–2013 before the updated NAP was published in 2014 (Ministry of Agriculture and Forestry, 2014). Both the 2005 NAS and the 2022 NAP have assessed risks related to climate change and identified and assessed adaptation options (Ministry of Agriculture and Forestry, 2005; Ministry of Agriculture and Forestry, 2014).

Currently, the NAP is undergoing a mid-term evaluation concentrating on its implementation. The aim is to assess progress in implementation and discover areas where further action is needed by gathering views from various administrative branches as well as from relevant regional stakeholders. This was done by conducting focus-group interviews with various administrations, organising regional stakeholder workshops and conducting a survey aimed to stakeholders. The results of the mid-term evaluation are published in 2019.

2.4.3 Governing biodiversity in Finland

Biodiversity is often referred to as a sector in Finland. The public authorities are responsible for the protection of nature and its biodiversity (Ministry of Agriculture and Forestry, 2014; Ministry of the Environment, 2016b). However, the governance of biodiversity is divided across administrations.

Ministry of the Environment steers and monitors nature conservation in Finland. It prepares legislation to maintain biodiversity and is responsible for the general monitoring of the implementation of this legislation. The national strategy and action plan for the conservation and sustainable use of biodiversity is a key policy instrument for biodiversity and it outlines objectives and measures for halting the decline in biodiversity by 2020 (Ministry of the Environment, 2012). The Ministry also prepares nature conservation programmes and establishes nature reserves under these programmes. Research institutes, such as the Finnish Environment Institute (SYKE), are also important actors in assessing various aspects of biodiversity. Moreover, the regional Centres for Economic Development, Transport and the Environment (ELY Centres) promote and supervise nature conservation and landscape protection, and safeguard biodiversity by e.g. establishing nature reserves in their respective regions (Ministry of the Environment, 2016b). The built environment sector is also managed under the environmental administration lead by the Ministry of the Environment.

Also natural resources and water are key elements in biodiversity. In Finland, natural resources (including agriculture, livestock, forestry, fisheries, game and reindeer husbandry) are governed by the Ministry of Agriculture and Forestry. Water resources management is governed by both the Ministry of Agriculture and Forestry (e.g. the regulation of groundwater, dams and flood and drought risk management) and the Ministry of the Environment (e.g. protection of natural water resources). Various regional and local stakeholders and municipalities are also responsible for aspects relating to managing both natural and water resources (Ministry of Agriculture and Forestry, 2014). The Ministry of Agriculture and Forestry is responsible for the overall coordination of alien species matters in Finland, such as implementing the EU and national invasive alien species legislation as well as the National Strategy on Invasive Alien Species (Invasive Alien Species Portal, 2019).

Furthermore, there are international aspects present in governing biodiversity. For instance, there is nature protection cooperation between Finland, Norway and Russia in the Green Belt of

Fennoscandia. This cooperation is developed so that the connectivity of the protected areas improves and there is growing awareness of the threats to the ecosystem services of the region caused by climate change. The responsibility of this cooperation is divided between ministries in Finland (Ministry of Agriculture and Forestry, 2014).

3 Methods and material

In this chapter, I elaborate how the study was conducted including types of methods and materials and how they were used, limitations of study, and ethical considerations. Demonstrating how the research was put together is essential, so that the study can be evaluated and even repeated, and in order for the research to have trustworthiness (Lincoln & Guba, 1985; Nowell et al., 2017).

This study was conducted as a data driven, qualitative thematic analysis. The term qualitative methods entails different types of methods used to gather, analyse and report data (Hesse-Biber & Leavy, 2008). In the thesis, qualitative research methods are used to analyse empirical material, identify the key findings and discuss them using tools presented in the background and theory chapters.

When it comes to adaptation policies, it is useful to distinguish between interventions that have simple, complicated or complex designs (Fisher et al., 2015, p. 14). *Simple* interventions are those where there is a straightforward logic between inputs, outputs, and outcomes. *Complicated* interventions may entail multiple components or stakeholders over long time frames. *Complex* interventions involve fundamental uncertainties, and often disagreement, about the relationship between inputs and outcomes (Fisher et al., 2015). Even though there are adaptation initiatives that are simple (there is e.g. agreement, certainty and well established monitoring and evaluation methodologies) and complicated (e.g. there is agreement but less certainty and they may require a broader set of approaches), many adaptation initiatives are complex and the fundamental uncertainties associated with climate change create particular challenges for implementation and evaluation (Fisher et al., 2015; EEA, 2014).

Using mixed methods can address some of the challenges of complicated or complex interventions as many adaptation initiatives and policies are (Fisher et al., 2015; Huitema et al., 2011). In this thesis, multiple methods were used to make a stronger base for the study, to minimise bias and to avoid relying on one single method or criterion as suggested by Fisher et al. (2015), Mickwitz (2003) and EEA (2015). In this study, the methods applied were selected mostly due to the mid-term evaluation process of the NAP as that provided a chance for me to take part in the data gathering process that was carried out during spring and fall of 2018.

3.1 Literature review

A literature review was conducted to further understand the topics and themes addressed in this study. This included theoretical and empirical literature related to adaptation and climate risk assessment and management. Relevant literature on biodiversity and climate change was also reviewed. The literature used in this study reviews the topics and themes from national and international perspectives. Relevant policy documents as well as both national and sectoral adaptation and climate plans[8] were also an important part of this study.

3.2 Data collection

In order to engage a broad range of actors and stakeholders at all levels, the data gathering process for the mid-term evaluation of the NAP consisted of two phases: focus-group interviews with various administrative branches at the national level and stakeholder engagement with other relevant actors. For the purpose of this thesis, the same data from the focus-group interviews and from the stakeholder engagement was used.

3.2.1 National administration

Focus-group interviews with relevant administrative and governmental officers[9] from various sectors and related ministries were conducted during spring and autumn of 2018. The administrative branches interviewed were built environment, energy, transport, water resources management, natural resources (including agriculture, forestry, fisheries, game and reindeer husbandry), national defence and health. These administrative branches were selected based on the representatives in the National Monitoring Group for Adaptation. The set of questions discussed followed the same structure in each interview and the questions are seen in Annex 1.

[8] The key climate policy plans and strategies for this study were: the NAP from 2014 (Ministry of Agriculture and Forestry, 2014); the NAS from 2005 (Ministry of Agriculture and Forestry, 2005); Adaptation Plan for the Environmental Administration (Ministry of the Environment, 2016a); Climate Policy Programme for the transport sector (Ministry of Transport and Communications, 2009) and the National Climate and Energy Strategy (Ministry of Economic Affairs and Employment, 2017).

[9] The representatives present at the interviews were public officers and experts from the administrative branch focusing on the national aspects of adaptation in the sector in question.

I was personally present in one of the interviews, which was the one with biodiversity administrative officials as that was conducted during the fall of 2018, which was in time with the thesis work. Other interviews had already been conducted during the spring of 2018. Not all the conducted interviews were used in this thesis to limit the search for data and material to certain sectors described earlier in the thesis.

A key phase of data analysis within interpretative qualitative methodology is recording and transcribing of the material (Bird, 2005). The administration level focus-group interviews were recorded and notes were taken during the interviews. For the purpose of this study, I transcribed the interviews with a gist using the preliminary notes from the meetings as a basis for transcription. The transcription was not done at a verbatim level, since the introductory statements from the interviewers followed the same structure in each focus-group interview and were thereby mostly excluded from the transcripts unless an interviewee made a comment found relevant to the introduction statements. However, the statements from the interviewees were transcribed as accurately as possible. Some utterances and sneers were also included in the transcription where seen necessary as it is important to retain the information in a way that is true to the original nature of the interview (Braun & Clarke, 2006).

3.2.2 Stakeholder engagement

The purpose of the stakeholder engagement was to find out the effectiveness of the NAP and to gather stakeholder views for developing activities. An important part of the stakeholder process was also to produce insights on what type of tasks should be emphasised in the implementation of the NAP. The aim was to identify how adaptation measures are proceeding in different sectors and regions, as well as to identify the possible themes that stakeholders think should be paid special attention to in the future. This was done by organising workshops and additionally conducting a survey to gather evidence for the mid-term evaluation process of the NAP. The survey was not used as data in this thesis due to the release schedule of the publication[10] so the emphasis in this section, and in this study, is on the workshops.

[10] The survey is published alongside with the results from the mid-term evaluation process in spring 2019.

Stakeholder workshops

During fall 2018, five regional stakeholder workshops in Finland were organised in Joensuu, Tampere, Helsinki, Rovaniemi and Vaasa. The aim of the events was to map the state of adaptation regionally and identify gaps and needs of adaptation actions. Each of these workshops focused on selected themes based on the aspects typical for the region in question. The participants were representatives from municipalities (e.g. emergency services and regional government agencies), research organisations, non-governmental organisations (NGOs) and the private sector. Additionally, there were also representatives from the Ministry of Agriculture and Forestry, SYKE and from Akordi Oy, a consulting company which was responsible for the facilitation of the workshops. At the beginning of the workshops, the objectives of the mid-term evaluation were presented following with a brief introduction of regional adaptation aspects by a local representative. After the presentations, there was an individual work phase at each event, where each participant pondered the state of adaptation through her or his own work or field of activity using a set of questions as a base. The themes addressed and the questions asked in the workshops are seen in Annex 2.

After the introduction and the individual work phases, the workshops were held as a round table discussion setting. In the workshop phase, the state of adaptation in the key sectors of the area was discussed by considering the vulnerabilities of the area and the critical factors for adaptation planning from the point of view of the stakeholder's own field. In the second phase, cross-sectoral groups were formed and in-depth discussions were held on identified gaps following with a discussion on what further action is needed to promote adaptation in the region. The participants were divided based on sectors represented at the meetings, and the table discussions were facilitated and notes were written down. These meetings were recorded, and the notes of key themes and topics discussed in each table were gathered and sent to the participants afterwards.

Even though the regional workshops were recorded, the recordings were not transcribed for the purpose of this study as the notes taken from the workshops were comprehensive and presented detailed input from the participants. Moreover, I was personally present in all five workshops and that enabled me to take more detailed notes in the meetings and follow (and facilitate when necessary), discussions that were more relevant from the research perspective for this thesis. As the stakeholder workshops were not transcribed, the quotes in Chapter 5 are only from the focus-group interviews.

3.3 Data analysis

Thematic analysis is a commonly used method of analysis in qualitative research, especially with researchers not yet familiar with more complex types of qualitative analysis. According to Braun & Clarke (2006), it is a method for identifying, analysing and reporting patterns within data. Thematic analysis has been described to give flexibility in the researchers' choice of theoretical framework when analysing qualitative data, while still providing a detailed and complex form of analysis (Braun & Clarke, 2006; Nowell et al., 2017).

In order to answer the research questions stated in this study and to identify, analyse and describe the themes emerging from the data, NVivo 12 qualitative data analysis software was used to perform a thematic analysis of the material. This enabled systematic organisation, coding and analysis of the material. The codes were mostly based on the coding scheme used in the mid-term evaluation process. However, the coding scheme was modified to meet the needs of this study keeping the research questions and the conceptual linkages identified in the background and theory sections in mind thus providing a theoretical perspective to the analysis as well. The transcripts from the focus-group interviews were uploaded to NVivo, and codes were generated based on the coding scheme used in the mid-term evaluation process and the theoretical approach used in the study. The codes were continuously identified and modified and they were finally checked to avoid repetition and significant overlaps.

The notes from the stakeholder workshops were also coded, but as they were a different form of material, they were coded manually based on the main codes generated in NVivo. The aim was also to search whether or not the stakeholder views supported the views from the focus-group interviews with administrations.

3.4 Limitations of study

There are challenges present with this research. For instance, there is information bias from the interviews and workshops that should be considered. A variety of actors from different sectors were engaged in the process to minimise bias, but it is still likely that some views from relevant administrative officers or other key stakeholders were missed. There might also be an information bias from the interviewees as the answers are subjective. Interviews can be a challenging method in the sense that the interviewees may also try to frame the case based on what they think is strategically beneficial for them, and this might go unnoticed when coding the data. This information bias was tried to be minimised by using a form of triangulation, in which

several methods are used instead of only one (Mickwitz, 2003), and that approach was applied here when selecting the methods used in the thesis.

Language and translation issues are also to be considered. All the interviews and workshops were conducted in Finnish and not all material was translated for this study. There also might be something in the translation process that cannot be translated (e.g. specific Finnish terms and phrases) and this might affect the interpretation of the material. For instance, the quotes used in the analysis sections were originally in Finnish, and all the nuances of spoken language and meaning of Finnish phrases might not be fully translated in English. The original and translated quotes are seen in Annex 3.

Furthermore, in order to be reflexive and objective, I have to be aware of my personal involvement with the issues present in this study. For instance, when gathering data for this process, I have come across situations, where the interviewees have stated cultural views that differ from my own. This might affect the interpretation of the results. Furthermore, in order to overcome the concerns in being biased, a clear description of analysis methods should be demonstrated, as suggested by Braun & Clarke (2006). Thus, I aim to be transparent both in the choice of my methods as well as in my findings.

The thesis working time is also limited and given the resources for the study, there is a possibility that I may have missed some relevant documents and literature related to the case, meaning that the study may not be comprehensive enough. With a longer research period, I could have retrieved more material and also considered to use alternative methods, but this was not possible within the timeframe.

Limitations of data and selected methods

There was an extensive amount of data gathered for the mid-term evaluation process (focus-group interviews, stakeholder workshops and survey) and as most of the same data was used for the thesis, this brought challenges to the framing of the study. The gathered data led to the possibility of taking many different pathways and analysing different aspects of adaptation. As climate change is a cross-sectoral issue (Brown, 2018; IPCC, 2014a; IPCC, 2018b), the adaptation aspects are also complex and cross sector borders. This reflected in this study by making it difficult to decide on one specific sector and frame a sector or theme to ultimately focus on.

The choice of methods is another possible limitation of the study. Some of these methods used in the thesis (focus-group interviews and stakeholder workshops) were not selected by me but were used as methods in the mid-term evaluation process. Thus, the data collection methods utilised in this study followed the same ones as in the mid-term evaluation. I could not affect the choice of interviewees from the administrations or the ones that were invited to the regional workshops. I also could not affect the questions asked in the focus-group interviews or in the stakeholder workshops. Most focus-group interviews were already conducted during the spring of 2018 before this study was started. The focus was also on multiple sectors and not only on biodiversity, so the data might not be as sufficient as if concentrating on climate change and biodiversity issues exclusively. This might be reflected in the thesis.

Also it could be considered, whether another type of analysis than thematic analysis should have been used here. The indirect risks and cross-sectoral impact chains addressed in this thesis have been so far less progressed in the science community than direct risks (Brown, 2018; Tuomenvirta et al., 2018), so this brought challenges to the analytical framing of the study. The choice of theories and the analytical approach might not be sufficient and this might be reflected in this study. The coding is a decisive part of the study and there may be an aspect being missed in the coding process due to lack of theoretical framing.

Ethical considerations

As material from interviews is used in the thesis, the information from them is addressed with confidentiality and anonymity is applied so that anyone sharing her or his views cannot be traced back to a certain person. The political and cultural values of interviewed people are respected, and the bias when e.g. transcribing the interviews was minimised by writing the statements from the interviewees as accurately as possible.

4 Theory

This chapter describes the theoretical understandings that are relevant to this study. These theoretical understandings and approaches presented in this chapter are important for the results and discussion chapters. First, the concepts related to assessing and managing climate risks are presented. Then, the importance of awareness is explained following a section on coordination of adaptation.

4.1 Assessing and managing the risks of climate change

It is important to understand what is meant by climate change impacts and how climate related risks are formed. The concepts in this section follow the IPCC terminology and form a base for the terms used in the thesis as well. The key terms and definitions in this chapter are written in italics.

The core concepts of climate impacts, adaptation and vulnerability in the IPCC Fifth Assessment Report (AR5) are shown in Figure 5. The figure demonstrates that the risk of climate related impacts results from interactions between climate change hazards, the exposure of the system to these hazards and the vulnerability of the system. Climatic changes and socioeconomic processes are drivers of hazards, exposure and vulnerability. The socioeconomic processes, which include socioeconomic pathways, climate actions on adaptation and mitigation and governance, are critical determinants of risk (IPCC, 2014a).

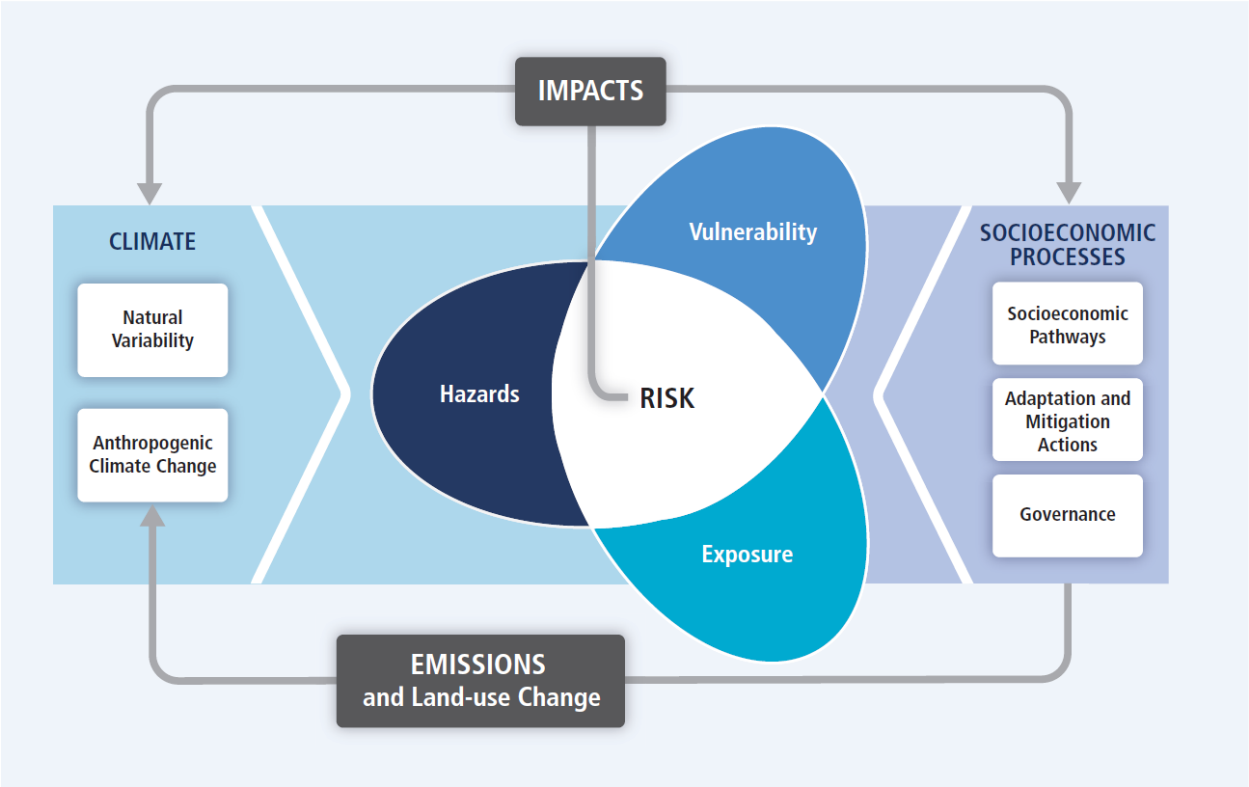

Figure 5. Illustration of the core concepts of the WGII AR5. Risk of climate-related impacts results from the interaction of climate-related hazards (including hazardous events and trends) with the vulnerability and exposure of human and natural systems. Changes in both the climate system (left) and socioeconomic processes including adaptation and mitigation (right) are drivers of hazards, exposure, and vulnerability (IPCC, 2014a, p. 3).

The concepts illustrated in the figure above are often used in the context of climate change. *Hazard* is the potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources (IPCC, 2014b; IPCC, 2018a). *Exposure* refers to whether an activity or agent (e.g. livelihoods, species or ecosystems, infrastructure, services, or economic, social or cultural assets) is located in a place or setting where they may be affected, harmed or threatened by effects of weather events and climate change (IPCC, 2014a). To what extent the system has been exposed to and incapable of coping with the adverse impacts of climate change is *vulnerability*. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (IPCC, 2014a; Ministry of Agriculture and Forestry, 2014).

Interactions between climate change hazards, exposure and vulnerability are all determinants of *risk*, which according to IPCC is the potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain (IPCC, 2014b, p. 40; IPCC, 2018a, p. 557). *Climate risk* is the potential harm to human activity and nature

caused by the climate and change in it, and combination of the adverse consequences that may be caused to human health and welfare, safety, environment, infrastructure, economic activities and cultural heritage. There may be both direct and indirect (climate) risks (IPCC, 2014a; IPCC, 2014b).

According to IPCC (IPCC, 2014a; IPCC, 2018a), *impacts* are the consequences of realized risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather and climate events), exposure and vulnerability. Impacts generally refer to effects on natural and human systems that affect lives; livelihoods; health and well-being; ecosystems and species; economic, social and cultural assets; services (including ecosystem services); and infrastructure. Impacts may be referred to as consequences or outcomes, and can be adverse or beneficial (IPCC, 2014a, p. 5; IPCC, 2018a, p. 551).

4.2 Awareness of climate impacts and risks

Awareness of climate impacts and risks has been recognised as one of the main factors that motivates adaptation action (IPCC, 2014a; Pidgeon, 2012; EEA, 2014; EEA, 2015). Socio-cultural factors, personal values and knowledge can limit effective adaptation, and while these constraints vary, it is essential to understand the cultural conditions (e.g. perceptions, beliefs, concerns) and the willingness of actors to adapt to climate change. This is because an actor's perspective can fundamentally further or hinder political, economic and social action to address risks associated with climate change (Adger et al., 2009). Given the nature of climate change adaptation as an issue, extreme events have played a particularly significant role in defining adaptation as a problem. Climate-related events such as floods and droughts as well as events such as heat waves, have played a significant role in pushing the adaptation agenda forward (Keskitalo et al., 2012). The political awareness of the need for adaptation has been enhanced by these extreme events, and the resulting concerns related to avoiding high future costs such as those identified in the Stern Report (Stern, 2006). Furthermore, in addition to extreme weather events, other common triggers identified for action on adaptation in Europe are damage costs, EU policies and scientific research (EEA, 2014, p. 34).

Awareness of the need for adaptation has a public dimension, and is reflected in public awareness at large, including within communities, businesses and organisations. It also has a political dimension that is reflected in adaptation reaching the national political agenda, and in the willingness to take adaptation actions (EEA, 2014). In addition, public and policy awareness

of the need for adaptation are also reflected by the need for and the provision of scientific evidence (EEA, 2014, p. 116). Although the scientific basis and levels of concern and awareness about climate change have been rising in many nations over the past 20 years, climate change has remained of low importance relative to other global or personal issues than would have been expected (Pidgeon, 2012; Weber, 2010). Pidgeon (2012) suggests that possible explanations are issues of fatigue, the impact of the global financial crisis, distrust and the influence of climate sceptics, and the deepening politicization of climate change. Kahan (2010) also suggests, that people tend to resist scientific evidence that could lead to restrictions on activities valued by their group, and that people's grasp of scientific debates, such as climate change, can improve if the information they receive is presented in a way that upholds their commitments and cultural values. Awareness and perception of climate change and adaptation information provided could be more effective if it is closely aligned to the cognitive and emotional needs of both policymakers and the public (EEA, 2014).

According to (EEA, 2014) the European countries that have progressed in the adaptation policy process are typically those that also have high levels of awareness of the need for adaptation. However, enhancing awareness of the need for adaptation also requires a wide variety of information, drawing on the best available scientific evidence. This information should be presented in a way that acknowledges the diverse needs of different audiences. Moreover, a better understanding of climate change impacts and vulnerabilities, in combination with efficient and effective ways of communicating, may contribute to further raising awareness about climate change adaptation among the general public (EEA, 2015).

For instance, in Finland there have been efforts to raise public awareness of climate risks and adaptation in conducting communication campaigns that emphasize the everyday adaptation actions for the public, such as supporting biodiversity in private gardens by planting versatile plants and trees, and by making contingency plans for private housing companies[11]. On a political level, at least some ministries have been making their own climate plans or programmes, some which have focused on adaptation alone (Ministry of Agriculture and

[11] During fall 2018, a communication campaign addressing everyday adaptation actions for citizens was launched. See https://tapio.fi/ilmastonmuutoshaltuun for more details (in Finnish).

Forestry, 2014; Ministry of the Environment, 2016a) and some integrating it in broader climate policies that focus more on mitigation (Ministry of Economic Affairs and Employment, 2017; Ministry of Transport and Communications, 2009). Most regions in Finland also have climate strategies that address adaptation at least to some extent.

4.3 Coordination of adaptation

Adaptation to climate change is inherently a cross-sectoral and -cutting issue that concerns all sectors of society, and as a multilevel governance[12] problem, it requires action from national governments to local actors (Sanderson et al., 2018). The general strategies that are developed at a central level need to be interpreted and applied at subnational levels, and activities have to be coordinated across multiple sectors (EEA, 2014; Keskitalo et al., 2012). According to the EU Adaptation Strategy (European Commission, 2013), one of the greatest challenges for cost-effective adaptation measures is to achieve coordination and coherence at the various levels of planning and management and this requires putting emphasis on cross-sectoral adaptation policy instruments. Coordination is also expected to reduce the risk of maladaptation, which only shifts the burden of adaptation from one sector or actor to another, worsens future problems of adaptation or increases the challenges of mitigation (EEA, 2013).

Horizontal (across government departments and sectors) and vertical coordination (between different administrative levels) are known to be generally important in systems with multilevel governance, and are identified as being important mechanisms in integrating adaptation into relevant policy areas (Bauer & Steurer, 2014; Sanderson et al., 2018; Schout & Jordan, 2005; EEA, 2014; EEA, 2015).

4.3.1 Horizontal coordination

According to Sanderson et al. (2018, p. 330) horizontal coordination refers to processes and institutions in place that aim at supporting the integration of adaptation into sectoral policies. Actors are responsible for different policy areas within an administrative level (e.g. national) to exchange information, and adjust their activities so as to ensure that adaptation efforts result in

[12] Multilevel governance refers to negotiated, non-hierarchical exchanges between institutions at the transnational, national, regional and local levels. It identifies relationships among governance processes at these different levels (IPCC, 2018a, p. 550).

coherent action to avoid negative policy spillovers and to maximize benefits. Inter-ministerial working groups or task forces are a common example of this mechanism to support horizontal coordination (EEA, 2014). This often enables policy development and exchange of information and good practices across sectors. Ministries of the environment or the use of natural resources are typically the ones responsible of carrying out the responsibility for horizontal coordination in adaptation. The most common form of horizontal coordination at the national level in Europe is the establishment of working groups or task forces that bring together representatives from different ministries and other organisations (EEA, 2014).

In Finland, horizontal coordination is organised through the National Monitoring Group for the National Adaptation Plan. This inter-ministerial working group is chaired by the Ministry of Agriculture and Forestry and brings together multiple sectors in order to monitor the implementation and evaluation of national adaptation policy (EEA, 2015; Ministry of Agriculture and Forestry, 2014).

4.3.2 Vertical coordination

Vertical coordination mechanisms refer to institutions and processes in place to support the integration of adaptation through multiple administrative levels within a country (i.e. supranational, national, provincial, regional, local/city levels). The process of vertical coordination entails information on and approaches to adaptation being transferred and exchanged effectively within each policy area from the national to the subnational levels and vice versa (Sanderson et al., 2018, p. 332). Vertical coordination comprises both top-down and bottom-up approaches to involve a wide range of government levels in adaptation and thus a wide range of knowledge on what is important and what can be done (EEA, 2014).

Although adaptation strategies and plans are often first adopted at national level, their implementation requires strong involvement at regional and local levels. Therefore, it is important to explore what happens at regional and local levels in tracking progress on adaptation. This highlights the need for vertical coordination of adaptation actions across different levels of governance, in addition to horizontal coordination across sectors and fields of action (Sanderson et al., 2018). Vertical coordination of adaptation is either a task of each sector ministry, or a more general task coordinated by the ministry in charge of adaptation at the national level. Similar to horizontal coordination mechanisms, vertical coordination takes place through joint task forces, panels and working groups as well as more informal channels of communication (EEA, 2014).

In Finland, the National Monitoring Group is an example of combining horizontal and vertical mechanisms as it includes representatives from subnational levels. In addition, sectors have their own vertical coordination mechanisms where adaptation is addressed. For instance, the environmental administration addresses adaptation through sectoral adaptation action plan (Ministry of the Environment, 2016a). Some sectors also integrate vertical coordination mechanisms related to adaptation to broader climate policies like currently in the transport sector in Finland (Ministry of Transport and Communications, 2009).

4.3.3 Engaging stakeholders

Engaging a broad range of stakeholders is important for effective adaptation and stakeholder support is generally needed to ensure long-term viability of organisations, as well as policies, plans and programmes (Christensen & Lægreid, 2019; Sanderson et al., 2018). National-level adaptation policies often rely on stakeholders in the design and implementation stages and stakeholder participation is an important way to make sure adaptation measures are integrated in the local context (Sanderson et al., 2018). According to EEA (2014; 2015), the stakeholders can help to gather necessary data and expertise; share results of MRE efforts with relevant audiences; raise awareness; and encourage learning from good practice. Usually, the stakeholders seen important for adaptation are groups from the private sector, interest groups (e.g. NGOs and farmer's associations), scientists and researchers, and the general public. It is also crucial to involve representatives from a broad range of sectors that can be linked to known impacts of climate change, for example, from insurance, agriculture and energy production (EEA, 2014).

However, involving many stakeholders in adaptation implementation and MRE requires significant effort and the involvement of many stakeholders and government levels is often considered as a challenge (Sanderson et al., 2018; EEA, 2014; EEA, 2015). Another challenge is the validity of stakeholder views on adaptation progress meaning that there can be a lack of transparency regarding the process of incorporating expert and stakeholder views into adaptation implementation and MRE methodologies. Moreover, it is difficult to know how the stakeholder views are balanced with information from other sources, if they represent an individual expert voice or if they speak on behalf of a sector or region thus leading to a possibility of a bias. Some sectors are also very broad and members may have conflicting views on progress and appropriateness of adaptation efforts (EEA, 2015). In general, the use of participatory methods is one important way to deal with uncertainty, with complexity and with growing demand for

transparency in public decision-making processes in engaging stakeholders and local communities in climate change adaptation (Sanderson et al., 2018).

4.3.4 Opportunities and challenges to coordination

While the horizontal and vertical coordination mechanisms have been found to be important in adaptation context, there are still challenges posed by them for implementation of an effective integrated climate change adaptation policy (Christensen & Lægreid, 2019; Sanderson et al., 2018). There are factors such as knowledge and information exchange, coordination of stakeholders, assignment of responsibilities, general transparency and institutional factors (e.g. legal frameworks) that can both support and present challenges to coordination (Christensen & Lægreid, 2019; Sanderson et al., 2018; EEA, 2014). In Europe, for instance, these factors have been identified to, when in place, contribute to successful coordination but when missing, make coordination more challenging (EEA, 2014). Table 1 presents an overview of some of these coordination factors and related challenges and opportunities.

Table 1. Examples of challenges and opportunities for coordination (adapted from EEA, 2014, p. 63).

Coordination factors	Challenges for coordination	Opportunities for coordination
Knowledge and information exchange	Lack of communication campaigns Insufficient information exchange and diffusion of studies Lack of platforms for knowledge exchange	Shared knowledge base with regional and local actors Raising actors' awareness and engaging them through various events
Coordination of stakeholders	Limited resources and involvement of relevant stakeholders Large number of stakeholders	Involvement of all sectors and relevant actors
Assignment of responsibilities	Scattered and unclear responsibilities in coordination of adaptation activities Continuity/permanence of coordination structures Lack of a responsible body with convening powers	Designated body in charge of coordination
Institutional factors (e.g. legal frameworks)	Lack of formal structures and agreements Conflicting legislations	Legally based framework for action
General transparency	Distrust in the decision-making process	Open dialogue between actors Likely acceptability of the actions taken

As horizontal and vertical coordination are important in systems with multilevel governance, the need for both mechanisms increase when countries advance to implementation and evaluation stages of the adaptation policy process (Bauer & Steurer, 2014; Sanderson et al., 2018; EEA, 2014). According to EEA (2014), when it comes to all stages of the adaptation policy process, horizontal coordination mechanisms were generally assessed to be more effective than vertical coordination mechanisms. However, as working groups or task forces are established most commonly to answer the coordination issues, the temporary nature of them may present challenges for cumulative learning, whereas councils or advisory panels can provide more permanent mechanisms that can support both horizontal and vertical coordination.

Difficulties experienced in vertical coordination might be because many areas of administration see that vertical coordination to the regional or municipal level is more challenging than horizontal coordination due to structural and cultural factors. Such factors are e.g. the local nature of practical adaptation actions and the relative autonomy of regional and local decision-making when it comes to the implementation of policies (Christensen & Lægreid, 2019). Moreover, there might be difficulties in getting sufficiently detailed cross-sectoral information on vertical coordination in adaptation as vertical coordination is generally a task of each sector of administration (Christensen & Lægreid, 2019; Sanderson et al., 2018). According to EEA (2014), when it comes to adaptation actions, rather than establishing new mechanisms for adaptation alone, vertical coordination of adaptation can also be mainstreamed into general administrative coordination mechanisms without the need for new permanent mechanisms.

The governance of adaptation takes place through both formal and informal institutions and networks of actors at different levels (Sanderson et al., 2018). Such networks provide opportunities for actors at subnational levels to engage in planned adaptation, but any lack of coordination at the national level may be an impediment for involvement (Juhola & Westerhoff, 2011). However, adaptation governance mechanisms have been found to depend not only on political systems but also on other variables such as financial and economic circumstances, cultural values and societal expectations (EEA, 2014; Sanderson et al., 2018). For the same reason, it is difficult to make any definitive claims concerning the differences in approaches to horizontal and vertical coordination. Whatever the approach, unclear responsibilities, conflicting values and interests, legal issues (e.g. conflicting legislations), limited cooperation among stakeholders and lack of knowledge exchange can become obstacles to effective coordination.

These challenges are likely to be reflected in incoherent policies for adaptation (Sanderson et al., 2018; EEA, 2014).

Addressing the challenges of coordination should be a top priority, although solutions to them are likely to depend on the particular societal context, including general governance structures (Christensen & Lægreid, 2019; Sanderson et al., 2018). Furthermore, there is considerable diversity in the ways coordination has been developed and implemented, for example, in European countries (EEA, 2014; EEA, 2015). This diversity in the coordination mechanisms and sharing of lessons learnt are likely to benefit the development of effective coordination for adaptation. Putting more emphasis on this in adaptation policies could contribute to the potential for learning and exchanging experiences that have strengthened coordination as also called for by the EU Adaptation Strategy (European Commission, 2013; EEA, 2014).

5 Results

Here, the results of the analysis of this study are presented. This chapter is divided into three main sections. Section 5.1 concentrates on climate risk awareness in general in the sectors. Section 5.2 concentrates on the identified direct risks to biodiversity following a section on indirect risks and impact chains related to biodiversity ending with a separate section on overall awareness of actors on biodiversity related risks. Section 5.3 analyses the coordination aspects concerning biodiversity across scales and sectors. The sections in this chapter are divided into different subsections relating to the themes relevant to this study. After each section, the key points are summarised.

The quotes in this chapter are from the focus-group interviews with administrations and the answers stem from the set of questions described in Annex 1. The quotes are translated from Finnish to English and the original quotes are seen in Annex 3. There are no quotes from the stakeholder workshops because unlike the administration interviews, the workshops were not transcribed and the analysis is based on extensive notes as described in section 3.3. The stakeholder views stem from the discussions based on regional themes and questions in workshops seen in Annex 2. Furthermore, even though the stakeholder workshops were regional, the data from them is handled here as representing views from stakeholders on a national level, although regional differences are emphasised if found relevant.

5.1 General awareness of climate risks

In order to identify risks that cross sector borders, it is essential to be aware of direct impacts and risks that emerge in different sectors. Therefore, this section focuses on the overall climate risk awareness in the analysed sectors both from administrations and stakeholders with a summary of key findings at the end of the section.

5.1.1 Awareness of climate risks in the assessed sectors in general

According to the NAP, the planning of adaptation measures must be based on impact and risk assessments and on the best available information (Ministry of Agriculture and Forestry, 2014). Based on the data, there is variation on how climate risks are identified in different sectors. In general, the direct individual and sectoral risks related to climate change are relatively well identified in administrations. However, the terminology used in adaptation context still caused some confusion among the interviewees:

"Adaptation as a term is difficult, it may not be understood. But if you talk more about risk management and what the risks mean, it opens up more. Things should be made even simpler. Agility is needed when challenges increase."

(Focus-group interview, natural resources)

This confusion over terminology was relatively often observed in the focus-group interviews, as it was not always clear, what type of actions adaptation entails and the interviewees often referred to climate change risks rather than e.g. impacts or effects. Moreover, when addressing risks, there is still variation between sectors. For example, there is a lot of information on direct climate risks in the energy and emergency services related to securing energy supply, in the built environment and in natural resources sectors, and according to the interviewees, the awareness of risks was considered high.

Representatives from the administrations in different sectors estimate that the link between risks and climate change is less known to operators, even though the risks themselves are identified. Especially in the context of energy matters, there is little contact with climate change, and the risks are addressed from the perspective of preparedness. The interviewees that pointed out matters related to energy seemed to share the idea that emphasizing the climate change link is not essential as long as action is taken:

"[The risks] are well identified but are not handled under climate change concept. Weather issues are well known on the energy side and [risks] are clear on the energy side."

(Focus-group interview, energy)

Conducting adaptation actions not necessarily under that term was also recognised by the interviewees in water resource management:

"Preparedness in water resource management is built-in, but the term adaptation is not used. Climate change is an important factor in the sector's preparedness and self-evident for the sector, but is it enough? It's still unclear."

(Focus-group interview, water resources management)

The interviewees in most sectors also stated, that usually some type of accident or emergency is needed until adaptation actions are called for:

"We need to go through the accidents to do something.
Consciousness often increases only through this."
(Focus-group interview, energy)

This attitude, that often something needs to happen in order for actions to take place, was seen in most focus-group interviews. Awareness is increased often through extreme events and accidents at a larger scale, which suggests that the approach to adaptation is reactive in many sectors.

The stakeholders from all five regions identified key themes on awareness, especially relating to local and regional issues. Representatives from most sectors in all regions stated that even though all risks might not necessarily be recognized yet, the ones identified have been tried to be taken into account at least to some extent. The exception to this was the health sector, which was not seen to be at the same level as other sectors when it comes to awareness of climate risks. The stakeholders also pointed out, that there should be more research of the impacts and risks on climate change in specific sectors, so that decisions based on sectoral information can be made.

In all five regional workshops, the stakeholders were not always certain, whether to label their actions as adaptation. For instance, the water resources management representatives in Helsinki stated, that there are quite many actions done (such as rainwater and urban runoff programs and flood strategies), but they are often referred to as preparedness rather than adaptation. In Joensuu, the stakeholders involved in water resources management stated that, for instance, the building of wetlands is promoted, but usually these actions don't use climate change as a driver or motivator.

Furthermore, the stakeholders representing the transport sector in Tampere stated that while the need for adaptation is generally recognized by different stakeholders, climate change work in e.g. road maintenance and transport systems is primarily related to mitigation and sometimes linkages to adaptation are difficult to make. The built environment stakeholders in Tampere also pointed out, that even though the awareness on climate change in general is widespread within the sector, adaptation is not talked about as much as mitigation, and sometimes it is also difficult to differentiate between mitigation and adaptation. In Vaasa, it was also seen to be sometimes difficult to grasp adaptation related issues, and that there is a need to better launch the term adaptation in everyday actions.

The stakeholders also stated in the discussions in workshops, that current adaptation and risk information is too general and as such is not suitable for planning or resourcing many adaptation actions, especially when it comes to applying them regionally. Moreover, the stakeholders felt, that it is difficult to allocate resources to uncertain risks and therefore it is difficult to allocate money for adaptation, and estimates on the costs of adaptation were called for. More climate change impact and risk information on regional aspects and e.g. more local adaptation plans were called for. However, the stakeholders identified mostly climate risks relating to the sectors they represented, and the indirect, cross-sectoral risks were poorly identified.

5.1.2 Summary

In general, there is variation between sectors on how aware the actors are of climate risks. For instance, both the focus-group interviews and the stakeholders pointed out, that the lowest level of risk awareness is in the social and health sector. Actors also stated at both scales that the trigger to action is often weather related accidents or even disasters making the approach to adaptation less anticipatory. Furthermore, in the focus-group interviews it was stated that there are different sectoral information needs for implementation when it comes to risk assessment and planning adaptation actions. Even though administrations focus on the direct climate impacts and risks occurring in the sectors, the interdependencies between actors as well as the indirect effects of climate change were emphasized.

In general the stakeholders stated, that implementation faces constraints still in many sectors in all regions which is in line with IPCC (2014a) that implementation in adaptation faces constraints at local and community levels. The stakeholders emphasised the need for local and regional risk assessments, concrete adaptation action plans and regional communication. These strategies need to be based on most recent information and on expert views. In general, it was seen that adaptation is reactive at the moment and this approach should be switched to be more anticipatory. There was also discussion on lessons learnt, and that gaps and needs across sectors usually emerge from crisis situations as stated by many emergency service representatives in the workshops. This is in line with the focus-group interviews. The stakeholders also pointed out some gaps and needs, including coordination needs. It was stated, for instance, that when it comes to adaptation issues, the more forums there are to deal with them the better, and that climate issues belong to everyone across sectors and scales. It was also seen important that e.g. municipality employees are aware of the climate risks and needs of adaptation to climate change in their work. Moreover, the stakeholders in many workshops also called for the need to target

information on weather and climate risks to residents through e.g. contingency and rescue plans. All in all, the stakeholder workshops and discussions in them were seen as useful and needed, and to open up new perspectives on climate risks and adaptation in all of the five regional events.

5.2 Awareness of climate risks related to biodiversity

This section focuses on climate risk awareness related to biodiversity by combining relevant literature and using the collected data described in section 3.2. First, the direct climate impacts and risks from climate change to biodiversity in Finland are identified using relevant literature as a basis. Second, the identified indirect climate risks and cross-sectoral impact chains related to biodiversity are analysed using the empirical material from the focus-group interviews and stakeholder workshops. Third, the awareness of actors on climate risks related to biodiversity is briefly analysed. Finally, this section ends with a summary on key findings.

5.2.1 Direct risks to biodiversity in Finland

The identified direct impacts and risks from climate change to biodiversity in Finland are presented in this section. The primary literature used here is the recent National Assessment of Weather and Climate Risks in Finland (Tuomenvirta et al., 2018) which contains the most recent assessment of hydro-meteorological and climatic risks for different sectors in Finland. Climatic risks were addressed following the IPCC AR5 concepts of hazard, exposure and vulnerability for risk assessment. Thus, both the changing climate and the role of socioeconomic factors on the risk formation, now and in the future, were considered to support the risk preparedness and adaptation to climate change at different levels of government and in different sectors[13] (Tuomenvirta et al., 2018).

When it comes to biodiversity, the most substantial impacts of climate change relate to changes in habitats and the species dependent on them, as well as changes in the ecosystem services maintained by them. In Finland, the direct impacts and risks from climate change to biodiversity

[13] The sectors examined in the national risk assessment were biodiversity; water resources and water supply; natural resources (emphasis on agriculture, forestry and fisheries); energy (mainly production and distribution networks); built environment; industry (including food production, mining and quarrying); transport (including logistics and telecommunications); finance and insurance, and health (Tuomenvirta et al., 2018).

and ecosystems have been recognised relatively well and while climate change may also improve the living conditions of some species, as a whole, it presents more of a threat than an opportunity to Finnish nature (Ministry of the Environment, 2016a; Tuomenvirta et al., 2018).

Species living in natural environments are constantly exposed to the impacts of weather and climate. This largely determines the survival and reproductive success of individuals and thus the boundaries of species distribution and the size of their populations. In addition to the climate, the occurrence of species is affected by other abiotic factors such as rock and soil and topography. Habitats consist of naturally occurring species in Finland and interactions between species, such as competition and predation, also contribute to the formation of habitats (Tuomenvirta et al., 2018, p. 11). Moreover, weather and climate have a crucial impact on the occurrence of both species and habitats in Finland. It can therefore be expected that a relatively small change in the average climate will have a strong impact on the occurrence of species and habitats. The warming that has taken place over the last two decades has already caused major changes in Finnish nature. For instance, vegetation production has increased widely in northern areas. Many species of southern origin, such as many butterflies and birds, are heavily proliferated and the distribution priorities and ranges of the species have moved towards the north. Similarly, many northern-native species have decreased and retreated from southern Finland. Significant changes have also been observed in phenology (i.e. the timing of biological phenomena), for example, the earlier development of vegetation and the early arrival of spring migration of birds (Tuomenvirta et al., 2018, p. 12).

According to Tuomenvirta et al. (2018) the main themes for direct climatic risks facing biodiversity in Finland are 1) changes and displacements in species distribution areas and abundance; 2) changes and disappearance of habitats; 3) the success of endangered species is further deteriorated; 4) degradation of ecosystem services; and 5) alien species benefit in relation to the original species.

Changes and displacements in species distribution and abundance

The rise in average temperature and annual heat sum, as well as the rarer winter periods with low temperatures, affect the occurrence of Finland's native species. Some of the northern species, such as the arctic fox, adapted to the cooler climate are diminishing, and there is a risk that they will disappear largely from the country. Correspondingly, the southern species are becoming more abundant and partly displaced the species adapted to the earlier cooler climate. These

changes extend across the country and are expected to intensify towards the end of this century. Specifically vulnerable species are those adapted to cool climate and that have poor mobility. The most significant social impacts of changes in species distribution areas are to primary production, where significant adaptation impacts can be expected (Tuomenvirta et al., 2018, p. 14).

Changes and disappearance of habitats

As with species distribution changes, the impact of climate change on habitats extends across the country and is expected to intensify as the end of the century approaches. Typical habitats for cool climates, such as fells and shrubs, are particularly vulnerable. Such habitats may possibly disappear completely or almost completely by the end of this century. As in the case of species, the greatest societal impact of habitat change is on natural resource depended sectors (e.g. to agriculture, forestry and game) in which significant adaptation impacts can be expected (Tuomenvirta et al., 2018, pp. 14-15).

The success of endangered species is further deteriorated

Many species are threatened by the scarcity and loss of suitable habitats and such species may face more problems in the future[14]. They are often unable to monitor the changing climate, because a network of suitable habitats is too rare. Inhabiting in open and scarce environments and poor mobility will increase the vulnerability of endangered species to weather and climate risks. The potential for adaptation of endangered species is generally poor, as they are often bound to rare or declining habitats and also have species characteristics that undermine their ability to adapt. The deteriorating success of endangered species have also some socioeconomic impacts as, for instance, non-governmental organizations and authorities working with the conservation of endangered species need to adapt their conservation measures to the changing circumstances (Tuomenvirta et al., 2018, p. 15).

[14] During the writing period of this thesis (from fall 2018 to the beginning of March 2019), the available Red List of endangered species in Finland was by Rassi et al. (2010), which was also the endangered species list referred to during the thesis writing period. However, on March 8th of 2019, the updated Red List of Finnish Species was published, and the amount of endangered species has increased from 10.5 % to 11.9 %. Main causes include e.g. the decrease in species habitats, and climate change continues to affect species and habitats especially in the Northern part of Finland (Hyvärinen et al., 2019). (Footnote amended on April 18th 2019.)

Degradation of ecosystem services

According to Tuomenvirta et al. (2018), the field of ecosystem services is very wide and covers a wide range of themes from basic biological production to the ability of habitats to prevent flooding. Recreational use of nature also depends on ecosystems and their services. The impact of climate change on ecosystem services varies widely across industries and it is not possible to demonstrate a general decline in ecosystem services. In addition, the assessment of changes in ecosystem services is complicated by the fact that the topic has still been relatively scarcely studied. Therefore, many of the forecasts are still based on expert estimates (Tuomenvirta et al., 2018). However, presumably the effects are strongest in cool climate-adapted ecosystems. In agriculture and forestry, rising temperatures potentially increase basic biological production and hence increase crop yields and growth. At the same time, the increase in plant diseases and pests can reduce crop yields or forest growth. Similarly, the depletion of pollinator insect stocks may reduce crop yields of insect-pollinated crops and increase cultivation costs. Because climate change affects all ecosystems in Finland, the production of many ecosystem services can change significantly, but further research is needed on the topic (Tuomenvirta et al., 2018, pp. 15-16).

Alien species benefit in relation to the original species

The effect of displacing the original species of the alien species is currently strongest in the southern parts of the country, but is predicted to intensify and spread towards the north by the end of the century. Alien species can already displace the original species in, especially in human influenced environments, but their impacts can be assumed to increase in other natural environments in the future as well, for example, in water systems (Tuomenvirta et al., 2018, p. 16). The proliferation of harmful alien species can be expected to increase future costs, for example, in agriculture and forestry. In addition, they hamper the work to protect endangered species and can also increase costs in this sector. Some alien species, such as giant pipes, also have human health effects. Legislation and practical measures to combat alien species have been promoted in recent years. For instance, alien species (their entry and monitoring measures) are regulated by the Act on Managing the Risk Caused by Alien Species (2015). In order to improve information, collect observations and enhance control measure on alien species, a national alien species portal has been established (Invasive Alien Species Portal, 2019). Improving the information on the occurring alien species is essential, as the control of alien species is the most effective and the cheapest in the early stages before they are more widely spread out (Tuomenvirta et al., 2018).

Current knowledge of indirect risks related to biodiversity

In addition to the described direct impacts and risks, climate change is also leading to indirect risk to biodiversity through changes e.g. in land-use. These may be more damaging than the direct impacts due to their scale, scope and speed, and may likely further reduce the resilience of ecosystems to climate change and their capacity to deliver essential services, such as climate regulation, food, clean air and water, and control of floods or erosion (Brown, 2018).

However, the impact chains in nature and nature-dependent sectors are very complex and largely still unknown (Tuomenvirta et al., 2018). Furthermore, the indirect risks caused by weather and climate hazards are more difficult to assess and often to manage as well. These can be climate change impacts like a migratory species or a bacterium, which create risks to e.g. health, the natural environment, the agricultural and forestry economy, and the game and fisheries sectors (Tuomenvirta et al., 2018). Even though attention has been paid to the management of harmful invasive alien species, there is considerable uncertainty in the risk assessment. The impact of these alien species and possible diseases and risks to health are also uncertain, as it is difficult to predict the development and exposure of the hazards (e.g. vector-borne diseases and diseases coming to Finland as a result of human movement) (Tuomenvirta et al., 2018, p. 68). There is also a lack of information and challenges present on how these risks cross sector, and national, borders and what kind of coordination and multilevel governance between sectors and across scales and actors is required (Brown, 2018).

Move, adapt or die – adaptation options for biodiversity

When it comes to biodiversity and climate change, plants and animals react to environmental changes by adapting, migrating or going extinct. Studies show, that species have adapted to past climate fluctuations. According to scholars, species have been able to survive new conditions in their habitat by changing either behaviour or body shape (Nogués-Bravo et al., 2018; Quintero & Wiens, 2013).

However, the rate of change for species is slow and it has been estimated that on average, some species adapt to different climatic conditions at a rate of only by about 1°C per million years. Past species transformations, when planetary temperatures rose drastically, took millions of years to occur (Quintero & Wiens, 2013). If global temperatures are going to rise at current rate, species will not be able to evolve quickly enough to adapt to the dramatically warmer climate

expected by 2100. The current and future magnitude and unseen speed of change in nature may push species beyond their ability to adapt (Nogués-Bravo et al., 2018). This means, that species simply do not have enough time to change their morphologies, for example, by altering the shape of their bodies so they hold less heat to compensate for rising heat levels. Moving habitats might also not be an option, especially for northern species or species living in mountain areas. As a result, many species might face extinction globally (Nogués-Bravo et al., 2018; Quintero & Wiens, 2013).

As stated by Tuomenvirta et al. (2018), the range of tools available to help species and habitats adapt to the changing climate is quite limited. As human-nature and natural resource-based activities are now very wide-ranging, land-use solutions that preserve the natural habitats of species as much as possible are seen as a key measure. This is likely to strengthen species populations and increase the likelihood of species shifting from one climate to another. The most important such a tool is a network of nature reserves that is as comprehensive as possible, both geographically and in terms of habitat occurrence. However, since nature reserves can, at best, cover only a small part of the total area of land and water areas, action is also needed outside them, in areas that are in normal economic use. In Finland, the current network of conservation areas is also heavily focused on the northern parts of the country. Examples of other actions include maintaining biodiversity-relevant areas in agricultural areas through environmental support (e.g. incentives aimed to preserving biodiversity) and better integrating climate change and biodiversity interdependencies into forestry (by e.g. improving forest management guidelines related to preserving biodiversity). Moreover, it would be particularly important to strive for the creation of ecological corridors in order to link nature reserves and thus enabling species to migrate between them (Tuomenvirta et al., 2018).

In general, changes mainly in temperatures and precipitation lead to direct climate impacts to biodiversity and ecosystems. However, there are also non-climatic factors that affect the natural environment and its vulnerability to climate change. These include, for example, pollution load and the intensity of the use of nature. Over the decades, climate change is also changing the environment through various biogeochemical processes. For example, soil processes accelerate, and precipitation as well as leaching increases in warmer climates. In addition, the vegetation zones and animal species move towards the north. Warming also improves the potential spreading of many invasive alien species as well as pest species affecting, for example, the vulnerability of agriculture and forestry (Tuomenvirta et al., 2018).

Climate change will gradually increase risks, especially for ecosystems and infrastructure. In terms of direct risks, Finland has a variety of existing tools and information and experience on how to reduce the risks from weather phenomena. However, the systematic assessments of these risks and how climatic changes affect risk management have been initiated only recently. New measures, such as nature-based solutions, as well as knowledge and experience related to them are also only emerging (Tuomenvirta et al., 2018).

5.2.2 Indirect risks and cross-sectoral impact chains related to biodiversity

This section presents the identified indirect risks and cross-sectoral impact chains using material from the focus-group interviews and the stakeholder workshops.

In general, indirect risks and impact chains were identified in almost all analysed sectors, although their identification and assessment is challenging and the terminology used is not consistent (indirect, cross-sectional, cross-sectoral and interdependent). However, the connection of biodiversity issues to other sectors was relatively often recognised. Moreover, most of the indirect risks and impact chains were identified in the focus-group interviews. For instance, in the built environment sector, it was stated that biodiversity is really dependent on decisions made in other sectors, and that there are situations where interests conflict quite easily, making biodiversity related matters more challenging to take into account in planning and decision making:

"Sectors have different opportunities to do different things, for example, biodiversity is extremely dependent on decisions in other sectors and there are conflicting situations, there may be contradictory goals and it is much more challenging, while in land use and regional planning it is not worth building so that we will stay under the flood."

(Focus-group interview, built environment)

Particularly the slowness of the changes and the hidden occurrences in biodiversity were seen as a challenge. It is easier to react to visible changes, but some effects of climate change on species and their distribution are only seen when their buffer is exhausted and often the effects are then irreversible. The loss of species occurs slowly and partly without sight and is often not noticed until afterwards, and these slow changes have no response function defined in the state budget. This is a loss of the intrinsic value of nature, which is very significant especially if it is related to

e.g. pollination services or food production by insects. The interviewees found that preparing for the deterioration and changes in habitats is difficult to predict, and even though some scenarios have been made (for example, pest scenarios conducted in the Natural Resources Institute Finland), more versatile set of scenarios of change and research related to the natural environment and species distribution and habitat changes were called for.

Risks related to species loss

The increasing loss of sea ice cover and changes that generates to aquatic systems and how that affects to biodiversity and species rose as a special concern in the interviews. There might be more species that will decline due to the diminishing sea ice cover in Finland, for instance, the Saimaa ringed seal and the Baltic ringed seal are both dependent on ice and are already among endangered species. All these changes in biodiversity might affect the livelihoods concerning natural resources, such as in agriculture, fisheries and forestry and alter e.g. the species choice of cultivated plants, and have an impact on of fish populations and thereby to fisheries.

It was also stated in the focus-group interview with water experts that issues relating to the preservation of local and small species could become national and even international:

"A local and small area issue can become national and global [...] *and the link between water theme and ice to biodiversity, for instance, the Saimaa seal and the Baltic Sea seal are fading. Also the black grouse has mating displays on ice. For example, these and other species dependent on ice are at risk to disappear"*

(Focus-group interview, water resources management)

The interviewees in focus-group interviews pointed out that species that live only in Finland and are dependent on ice will disappear globally if they disappear from Finland. Other species might also be severely affected by loss of ice cover, for example, the black grouse has mating displays on ice and there might be loss in the total number of black grouses, if the mating displays are prevented due to loss of ice cover in the future.

These losses can have cascading effects on many economic activities. The water resources management sector also pointed out the changes in precipitation that can affect both the conservation of the species and also indirectly to livelihoods. For example, the limit of salinity in the Baltic Sea may change when more fresh water comes into the Baltic Sea with rainfall which

in turn might have a negative impact on e.g. blue mussels that may not survive in the future. The loss of blue mussel can have many cascading effects on other species, as well as economic effects, as blue mussels clean the water. The impacts of losing one key species can thus be significant and even unpredictable and bring more risks to economic life in addition to the impacts this might have on the natural environment.

Risks from diseases and pests

In the natural resources focus-group interview, the impact of potential diseases (such as bird flu and swine fever) and pests as well as risks from alien species to this sector and to e.g farm animals was highlighted. These risks are expected to increase as the species and their distribution change due to climate change. In addition, the game industry strongly relates to natural change and in reindeer husbandry, for example, access to and quality of lichen is essential (e.g. mold in the lichen is harmful) and the poor quality of lichen reflects negatively on the economic activity in these sectors. In Lapland, the stakeholders from fisheries, reindeer husbandry, forestry, agriculture and bioeconomy stated that already a great deal of attention is paid to the prevention of insect damage and active removal of alien species. However, if the risks brought by them are increased in the future, this will require even further risk management efforts and economic input from different actors.

Land-use and biodiversity

The impacts and risks of climate change to land-use and connections to biodiversity were pointed out in many focus-group interviews, for instance, the biodiversity representatives stated:

"If we consider protected areas and the surrounding land use, for example, from a forest and forestry perspective, there are likely to be major changes as a result of climate change, for example, what species are grown. Climate change impacts for land-use have also implications for safeguarding biodiversity."

(Focus-group interview, biodiversity)

For instance, the focus-group interviews with both biodiversity and natural resources sectors highlighted the need to preserve in advance the areas and animal populations that are not in acute danger yet to avoid the loss of organisms and cascading effects. Moreover, land-use based adaptation solutions for biodiversity and species conservation were seen, for example, as an increase in wetlands and protected areas. The interviewees from the built environment sector

stated that securing green passages and ecological connections are also relevant in land use planning and biodiversity. They also pointed out, that prioritising measures which are both adaptation and, for example, promoting water protection, is important. The indirect risks of land-use change on biodiversity and its protection were pointed out to be very important and were highlighted in the built environment, natural resources and biodiversity sectors. The measures taken in land-use were also seen as the main measure to reduce climate risks to biodiversity. However, this brings challenges in combining economic activities with nature conservation measures.

Vegetation changes

As precipitation increases and the conditions of the growing season improve, the amount of vegetation on the sides of the railway network may increase, which will require more maintenance from the transport sector. For instance, the challenge posed by the possible glyphosate[15] ban for the treatment of vegetation along the railway network was also raised. It is estimated that vegetation alongside the tracks will increase with climate change but with the ban on glyphosate, the management of vegetation will be more difficult, which makes it challenging to maintain the railway tracks and thus also traffic and logistics in the area. These bans are implemented to protect biodiversity but they can also affect safety issues on the transport sector, as vegetation might be more difficult to remove with other methods. According to a transport sector representative in the focus-group interview, the potential cost of removal of vegetation using other means than pesticides can be tenfold.

Biodiversity and health

The indirect climate risks of biodiversity on health are still quite unknown but the focus-group interview in the health sector highlighted the potential increase in the number of vector-borne diseases (e.g. tick-borne fever) transmitted from animals to humans. This will have implications to the health sector and possibly increases costs related to dealing with these diseases.

Biodiversity linkages to food production and other economic activities

[15] Glyphosate is a herbicide that is used for controlling weeds and excess vegetation in e.g. agriculture and in road and track maintenance.

Food production and availability are linked to biodiversity as well as to emergency supply which was pointed out in the natural resource sector focus-group interview. For instance, at present, cereal stockpiling is half a year, which may be inadequate in the future, if the amount of (climate) refugees and immigrants will possibly increase in the future. Raising the degree of cereal stockpiling was pointed out as a means of preparing for this possible increase in food demand. However, the crop yields might suffer in the future due to extreme weather events such as droughts as well as due to biodiversity loss. On the other hand, different plant breeding programs are being developed that aim to introduce new plants for food production. These plant species will spread to the latitudes of Finland as a result of climate change and might be new to Finnish agriculture.

However, these new species might bring more risks to food production and health, and this was mentioned in the stakeholder workshop in Tampere. As crop species change, new diseases might emerge, such as the African swine fever. Moreover, the risks of these new, partly still unknown species to already existing species and habitats in Finland are not yet known. There were also some discussions in the workshops in Lapland and Helsinki on immigration and what type of pressure this brings to food production and ecosystem services. Furthermore, the impact of a changing climate to Arctic nature worried the stakeholders in Lapland, as the region is heavily dependent on ecosystem services (e.g. recreational use of nature, and the provision and quality of natural products). Also the stakeholders in Lapland stated that the Finnish nature is Finland's main tourist attraction and as climate change jeopardises the current Arctic nature, changes in species and habitats might have negative effects on tourism and other livelihoods dependent on the natural environment.

5.2.3 Awareness of actors of climate risks related to biodiversity

The overall view from the focus-group interviews and stakeholders was that growing attention is being paid to climate change and biodiversity related matters. For instance, the biodiversity sector representatives in the focus-group interview stated, that the estimates how climate change affects species and habitats have been careful and mostly relating to fell and coastal habitats, but over the past ten years, the awareness on climate change impacts and risks on biodiversity has increased. There is also recent research conducted in Finland that brings together existing research data on species and habitats and on their response to climate change (Virkkala et al., 2019). The aim of this article is to find the most vulnerable species and habitats to climate

change based on current knowledge and recent findings so that their vulnerability can be taken into account in, for example, conservation planning.

However, the stakeholders representing biodiversity sector in the Joensuu workshop stated, that the need to adapt has been recognized but on a more general level, and the level of awareness is not necessarily on the same level among all relevant decision makers. For instance, it was pointed out, that even though climate change has been studied from a natural science point of view for decades, and that there is knowledge especially on various species, there are still gaps in recognizing impacts especially for habitats. It was stated that the efforts made to conserve biodiversity also enhance adaptive capacity, but even though there are efforts, for example, to generate more conservation areas, this might not be enough. Also the possible impact of alien species was emphasized. It was also pointed out, that the national and global research might not support the regional adaptation work regarding biodiversity. The issue that the impacts of climate change to biodiversity might not be visible before it is too late, worried the stakeholders as well as the administration representatives.

Even though biodiversity was a specific theme only in the Joensuu workshop, biodiversity related issues were raised in other workshops among stakeholders and linkages to biodiversity were brought up among e.g. water resources management, agricultural and forestry sector stakeholders as well. When it comes to implementation and follow-up of measures regarding biodiversity, the overall view from the stakeholders was that some adaptation actions are in place, but the situation is still poor and that biodiversity is easily affected through decisions from other sectors. In general, adaptation actions for biodiversity were seen as relatively difficult.

Ecosystem services and extending the network of protected areas

There was also discussion amongst the biodiversity sector representatives in the focus-group interviews that in biodiversity, the focus has been on the issues relating to the conservation area network and that there are relatively wide knowledge gaps in climate change impacts on ecosystem services[16]. The interviewees stated that this aspect should be better taken into account

[16] Ecosystem services refer to the benefits (and occasionally losses or detriments) that people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and

in the future. Moreover, the water resources management representatives in the focus-group interview stated that in biodiversity related issues, ecosystem services should be further considered in e.g. inland waterways and seas. Marine areas were also seen important to be more included in the network of protected areas, and it was stated that it is important to know whether they are in the right places for another hundred years. They also mentioned that one species can have cascading effects on many other species as well as sectors:

"Ecosystem services should also be considered more extensively on inland waterways and seas. Intensive research is ongoing here and in the rest of the world. From there, you get clear numbers of the economic effects of how the disappearance of mussels, for example, affects. [These are] important cross-sectoral issues and impact chains."

(Focus-group interview, water resources management)

Compared to species and habitats, the impacts of climate change on ecosystem services is an extensive field and not well known yet. In the biodiversity focus-group interview it was stated that the work on how climate change affects to ecosystem services is only just beginning, and even though there are EU strategies that relate to this aspect, the interviewees stated that Finland is just starting the work related to climate change and ecosystem services. This was pointed out as a research topic that should be paid more attention to in the future but it was also stated that it is an extensive field that requires a multisectoral and interdisciplinary approach. The need for coordination across actors and scales was also called for when addressing this theme.

5.2.4 Summary

The awareness of direct impacts and risks to biodiversity is growing across sectors and, for instance, there is ongoing research how species and habitats are responding to a changing climate. Especially the direct risks to certain species are relatively well identified. However, there are still knowledge gaps on how habitats are affected by climate change. Also the need for information on climate change impacts and risks on ecosystem services was identified.

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disease control; and cultural services such as recreation, ethical and spiritual, educational and sense of place (Díaz et al., 2015).

When it comes to awareness of indirect risks and cross-sectoral impact chains, actors from almost all sectors identified indirect risks and impact chains related to biodiversity, especially in sectors related to natural resources and environmental management, such as agriculture, forestry and built environment. Also other actors e.g. from transport and energy sectors identified risks and impact chains as well. Especially among the public officials in the focus-group interviews, the identification was on a relatively good level, whereas there was less identification of them in the stakeholder workshops. In general, however, the actors from all sectors are identifying and focusing on the direct risks of climate change, and the handling of indirect risks is perceived as difficult and complex both in administrations and among stakeholders. The cross-administrative nature and connectedness of various climate activities affect how indirect risks and impacts are identified and dealt with in the sectors. This poses a challenge for the administrations and makes the overall coordination of adaptation related activities difficult. Many different sectors have begun to detect cross-sectoral risks and themes, but the segregation to their own sector-specific activities might make it challenging to identify and promote the matters.

The uncertainties about the magnitude of climate change might still cause some confusion of what kind of impacts and risks are expected. This might reflect on the overall identification and awareness of impacts and risks and also to what kind of adaptation measures are needed in response. Furthermore, the impact chains in nature and nature-dependent sectors are very complex and largely still unknown and it is unclear, how these risks might affect across sectors. These aspects could reflect in the decision-making processes relating to conserving biodiversity.

When it comes to managing different climate risks to biodiversity, both the administrations and the stakeholders identified different land-use related solutions, such as building wetlands, as most important adaptation measures. The importance of conservation areas was also emphasised. Many representatives from different sectors, such as from the built environment, natural resources and water resources management also saw nature-based solutions, ecosystem-based adaptation and the designing of wetlands as key measures. The need to consider ecosystem services in decision-making was also called for.

In general, cross-sectoral activities on biodiversity as well as in adaptation activities were considered important. However, actors at all scales stated that working in silos within a sector is a challenge when identifying and promoting adaptation activities outside administration borders and activities. According to many interviewees, when finding solutions to issues on biodiversity

and adaptation, instead of working in sector silos, it is important to take better into account the cross-sectoral perspectives of adaptation activities in different sectors and find linkages to sustaining biodiversity as well. Moreover, when it comes to adaptation activities, actors at all scales also pointed out that in addition to national coordination efforts, international coordination should not be forgotten and that lessons can be learned from good examples outside national borders as well.

The cross-cutting and far-reaching nature of biodiversity and adaptation raise the need for coordinated efforts in various sectors and across scales since both these themes evidently cross sector borders and managing issues related to them cannot be limited only to the environmental sector. Furthermore, the above mentioned measures of ecosystem-based adaptation and nature-based solutions call for an interdisciplinary and cross-administrative approach. Therefore, when finding solutions for both reducing risks to climate change and for conserving biodiversity, cross-sectoral coordination is required.

5.3 Cross-sectoral coordination

Like climate change, biodiversity is a theme that spans across sectors and involves various actors of the society and coordination across sectors and scales is needed (Brown, 2018; Sanderson et al., 2018). Coordination between actors is required as both adaptation and biodiversity are cross-cutting themes to which sector borders can be challenging to apply. This further underlines the need for cross-sectoral coordination and collaboration as biodiversity is easily affected through decisions from other sectors and as adaptation activities have to be coordinated across multiple sectors and administrations as presented in the above sections.

The coordination aspects related to biodiversity and climate change are analysed in this section using the focus-group interviews and stakeholder workshops as materials. First, this section identifies, what is the current state of coordination across sectors in biodiversity related matters. Then the coordination challenges are addressed following with opportunities and a brief look at suggested further actions concentrating on biodiversity.

5.3.1 Current state of coordination related to biodiversity

National coordination

Both the public officials in the focus-group interviews as well as the stakeholders identified quite clearly the need to collaborate between various sectors. There is already some cross-sectoral coordination in biodiversity related matters. For instance, according to the administration

representatives and stakeholders from the biodiversity sector, there is coordination at least on some level and there are efforts made especially with actors from forestry and agriculture. Also other actors involved in land-use activities (such as from the built environment sector) were seen essential for biodiversity. In general, the stakeholders stated that there is more adaptation related vertical coordination in biodiversity than cross-sectoral coordination. Moreover, it was recognised at both scales (administration and stakeholders) that research institutes, such as SYKE and universities, are important actors and coordination partners in biodiversity issues.

It was also stated, that climate change can have a considerable impact on boreal nature, and at least the impact of forestry on biodiversity will not be reduced in the future. Therefore linking forestry to sustaining biodiversity will become even more important. However, when it comes to adaptation and biodiversity, it was seen that the work of environmental administration has just started:

"Environmental administration is still in its infancy related to this, measures have been only recently added to the adaptation program, these [measures] affect how we discuss [the matters] with other sectors, what is known and what is the level of preparedness."

(Focus-group interview, biodiversity)

There was also a call to better involve and coordinate more actors in the biodiversity and adaptation work especially from the third sector and organisations, and the importance of involving multidisciplinary actors was emphasized. For instance, more companies and NGOs to join the climate adaptation and biodiversity work were called for in the stakeholder workshops. In general, the stakeholders saw that the cross-sectoral coordination between actors is relatively poor when it comes to adaptation and biodiversity and implementing adaptation actions is still in its infancy.

International coordination

Cross-border coordination in biodiversity related matters was raised especially in the focus-group interviews. For instance, it was stated that more resources and e.g. projects are currently directed towards cross-border cooperation also from the Ministry of Foreign Affairs (in addition to the Ministry of the Environment). Important financial instruments to these cross-border environmental issues come from the EU. Arctic matters, however, are now at the center. It was also stated, that it is important to identify overlapping international work done in the cross-

border boreal zone. For instance, it is not always clear what research is conducted in Sweden related to biodiversity and climate change in the area and finding "grey literature" on this would be important (i.e. there are studies and literature in Swedish that may not be found in English).

In natural resources and in built environment sector focus-group interviews, there were some cross-border efforts for coordination recognised relating to biodiversity. For instance, the Arctic forum, the Arctic alien species program, the Nordic Council of Ministers working groups and the Blue Bioeconomy working group were mentioned. There is also cooperation from the Ministry of Agriculture and Forestry and the Ministry of the Environment with Russian authorities. However, more horizontal coordination on a national and international level was called for:

"We are waiting for the [Finnish] Climate Panel to grasp the biodiversity issues. It would be good to have IPBES and IPCC discuss with each other as well."
(Focus-group interview, biodiversity)

The public officials representing biodiversity stated as well that efforts have been made at both national and international level to find common benefits. Finland is already, for instance, part of the Green Belt of Fennoscandia[17] as well as part of international cooperation through various biodiversity related agreements, such as the Convention on Biological Diversity (CBD)[18]. Furthermore, the interviewees saw that if good climate decisions are made, biodiversity decisions can also be made at the same time, combining these two perspectives in order to find synergies on ecological and economic levels. In general, however, it was seen that there is a lack of resources when it comes to biodiversity related matters and more resources to biodiversity and adaptation work were called for.

[17] Green Belt of Fennoscandia is cross-border cooperation between Finland, Norway and Russia aiming for biodiversity cooperation. See http://www.ym.fi/en-US/International_cooperation/Green_Belt_of_Fennoscandia

[18] The Convention on Biological Diversity (CBD) is a legal framework that exists for countries to protect biodiversity together. See http://ec.europa.eu/environment/nature/biodiversity/international/cbd/index_en.htm

5.3.2 Challenges for coordination

Most of the challenges addressed in the focus-group interviews and stakeholder workshops related to knowledge and information exchange, conflicting values and interests, institutional factors (e.g. conflicting or missing legislation) and assignment of responsibilities.

Knowledge and information exchange

Even though the administration officials from various sectors stated, that there is at least some cross-sectoral coordination between actors in biodiversity related matters and that cooperation between actors is improving, there were challenges identified for knowledge and information exchange as well. For instance, the biodiversity administrative officials in the focus-group interview stated that at least in international agreements, there are still often silos for biodiversity and climate issues. These silos make it more difficult to address both topics and to make sure that biodiversity issues are also considered in adaptation work.

Most of the challenges addressed by the stakeholders related also to knowledge and information exchange. For instance, all five regional workshops emphasised the need for regional adaptation related knowledge and information exchange, and called for more centralised forums from which to find relevant information to make the issues more tangible for regional decision makers. It was emphasised that adaptation and biodiversity related solutions might not be the same across regions as Finland is a long country and species and habitats distribution varies. Climate change related information was also seen to be fragmented in several data locations and this was seen as a major challenge. There was also a call to further develop risk management systems and spatial data to support adaptation and e.g. develop insurance policies related to it.

Conflicting values and interests

Conflicting values and interest with biodiversity was a theme that rose from especially from the focus-group interviews. For instance, in the transport sector focus-group interview, conflicting interests with environmental and transport policy objectives were identified. For example, removing trees to build infrastructure will affect species and habitats and has mitigation aspects as well:

"In general, biodiversity issues can be contradictory […] *e.g. removal of trees affects the carbon sinks, biodiversity and possibly alien species."*

(Focus-group interview, transport)

The previously mentioned ban on glyphosate was also seen as an example of a conflicting interest, especially from the transport sector point of view.

In the built environment sector conflicting interests were also discussed, especially in terms of biodiversity and nature conservation. The interviewees pointed out that current land-use changes and impacts on species and habitats are often parallel to the negative effects of climate change. Therefore, when managing climate risks, the impact of land-use on biodiversity and its protection should be taken into account. Especially the northern species are vulnerable to the impacts of climate change and land-use changes can affect this, for example by maintaining and expanding the current conservation area network. Conflicting interests were also recognised with forestry and biodiversity as well. With climate change, the growth of forests will increase and the forest industry will grow. This might lead to undermining the importance of ecosystem services and other diversity provided by forests.

Assignment of responsibilities and institutional factors

The built environment officials in the focus-group interview also stated that working in silos is challenging when it comes to coordinating adaptation issues and sometimes it is difficult to know which (sectoral) risk is more of value or relevant, or what relations does that sectoral risk have to the risks from other sectors. The issue of who coordinates the overall managing of the risks was also raised. Many public officials in most focus-group interviews as well as stakeholders in most workshops pointed out the upcoming regional reform[19], and that what would be the role of the state and the municipalities in coordinating adaptation activities after the regional reform. The division of responsibilities in turn affects e.g. land-use and biodiversity related matters and something might go unnoticed if there is a lack of coordination when dividing regional tasks. It was also pointed out, that it is sometimes difficult to see the

[19] The regional reform in Finland is planned to come into effect in 2021. The reform is connected to reorganising the health and social services and aims for the Finnish public administration to be organized on three levels: the state, the province and the municipality instead of the current division between various regional and local organisations.

boundaries between administrations, for instance, there are many different actors from various organisations involved in flood risk management. According to the built environment sector representatives in the focus-group interview, a good starting point here is that there are legislation links between actors.

5.3.3 Opportunities for coordination

Even though the general consensus across scales and actors was that more horizontal and vertical coordination is needed in biodiversity and adaptation related issues, there were some cross-sectoral coordination opportunities identified as well. Some further actions raised by the actors are also briefly addressed here.

Knowledge and information exchange

According to the stakeholders, even though the knowledge and information exchange between sectors should be improved and that information is scattered across scales and actors, the stakeholders also saw an opportunity in managing the information. Many actors involved in adaptation were also seen as an asset, since there is a possibility to share views with actors across scales with different perspectives. For instance, concerning the fragmentation of data, an idea or data bank for best practices for different actors in climate change adaptation (regardless of who has assembled or collected the data) was suggested in Helsinki and Joensuu. The stakeholders also stated that in addition to regional forums, the Finnish society could learn from good examples of collaboration from other Nordic countries for instance. The examples of Copenhagen[20] and Malmö in their efforts to increase the city's blue and green infrastructure and to prevent flooding using nature-based solutions were mentioned. The Helsinki workshop also called for a joint international portal to gather national and regional examples, lessons learnt and best practices, especially from other Nordic countries.

Institutional factors and assignment of responsibilities

The forthcoming regional reform in Finland was seen as one possible means to solve the coordination issues as the county could act as a main coordinative actor. This was stated in

[20] The City of Copenhagen has made several efforts to manage the increasing weather and climate risks, e.g. by combining nature-based adaptation solutions to urban planning. See e.g. https://international.kk.dk/artikel/climate-adaptation

almost all focus-group interviews and stakeholder workshops. For instance, in the natural resources focus-group interview, it was seen that the regional reform is an opportunity also for adaptation, when all the activities are under one roof as there is a possibility to coordinate with different actors on these themes and further consider the multiple perspectives related to adaptation.

In the water resources management focus-group interview, linking agreements and directives to climate change was seen important. In the future, agreements and EU directives should also take better account of global biodiversity agreements. The public officials stated that change has already taken place and, for example, the goals of sustainable development are more often linked to issues such as biodiversity and marine affairs. The public officials representing biodiversity also stated that there is hope in the EU in finding more connections and linkages between climate and biodiversity agreements and more discussions are already being initiated. Also some existing frameworks were seen as good coordination examples, such as the Ramsar Convention on Wetlands[21] was mentioned. However, on a national level, the biodiversity and natural resources public officials also noted that more investments to adaptation activities are needed and financiers such as Sitra **(**the Finnish Innovation Fund**)** and Academy of Finland should be even more involved. Furthermore, more marine and nature conservation agreements were called for.

Further actions stated by the actors

Solutions that are applicable in many sectors were often discussed in the interviews and in the workshops, such as maintaining and building more wetlands that are adaptation measures for both biodiversity and agriculture. These solutions were seen as a particularly important means to adapt and to benefit multiple sectors. Furthermore, the water resource management stakeholders in Helsinki and Joensuu stated that when it comes to storm water management, there is still too much grey infrastructure being used and that the current drainage system might not be the best way to manage increasing precipitation and urban runoff. Increasing green landscaping and green infrastructure and implementing nature-based solutions were seen as key future measures.

[21] The Ramsar Convention on Wetlands, also referred to as the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. See https://www.ramsar.org/

However, coordination between actors and knowledge sharing are important when utilising and implementing these sustainable, nature-based solutions.

Actors at all scales also pointed out the importance of linking land-use goals and adaptation. For instance, the stakeholders from the built environment sector in Tampere stated that green infrastructure, parklands and urban coves should be better taken into account in urban planning. Human welfare in municipalities can also be increased through adaptation measures, e.g. by increasing local production and nature tourism. It was also stated that there is adaptation related data, but it could be more efficiently shared among actors, also in more grassroots level actors. Cross-administrative working groups were also seen key here.

In general, it was found that measuring the effectiveness of adaptation actions is challenging. Suitable indicators were called for in many focus-group interviews and stakeholder workshops to monitor the consequences of climate change. The current indicators (or lack thereof) were found not giving enough information on climate change adaptation.

5.3.4 Summary

In general, there were quite many conflicting values and interests identified in the focus-group interviews related to biodiversity and to the changes brought to it by climate change. The interviews also highlighted that climate policy and biodiversity often do not meet in decision-making, but are segregated from each other. The debate over climate change and policies related to it has taken the resources from preserving biodiversity and they have been separately discussed leading to separate decision-making silos for climate and biodiversity. It was also found from the data, that the need for coordination in adaptation is recognised, but systematic planning and implementation relating to it is missing. Actors at all scales also often pointed out the importance of collaboration with research institutes and emergency services as they are concrete partners for regional risks in collaboration on e.g. environmental damage, chemicals and flood risk related matters.

Finland’s uncomplicated horizontal coordination was often seen as strength between administrative actors and collaboration was seen to be working well, but with other key stakeholders there is still room for improvement. However, even though coordination was seen to work at least to some extent, there was also a call to enhance adaptation related collaboration, to continue the cross-administrative work and make sure the actions are implemented as well.

For instance, the natural resources representatives in the focus-group interview stated that better steering from “top level” in adaptation issues was required and since there are so many actors involved in the adaptation scene and the topic is so diverse, there might be a need to reorganize the administrative tasks. Responsibilities are still seen to be somewhat unclear, especially in biodiversity related issues. There was also discussion that enabling cross-sectoral coordination and networking possibilities at the political level is key, and that this should be considered in the regional reform for instance.

In all of the stakeholder workshops it was pointed out, that the challenge is that there is a lot of information being produced, but it is dispersed, sometimes difficult to find and that the regulation on adaptation is missing. The questions of how to solve the issue of data fragmentation and how to use data more efficiently were raised often. However, in terms of knowledge and information sharing, many actors in the climate field were also seen as a possibility as collaboration between actors was often seen as an asset in the Finnish society.

6 Discussion

This chapter discusses the results of the analysis presented in Chapter 5. First, the discussion concentrates on the awareness and identification of climate risks and impact chains risks related to biodiversity in the sectors. The discussion then continues to reflect on the findings on challenges and opportunities of cross-sectoral coordination related to biodiversity and adaptation. Finally, some further research needs with brief reflections regarding the analysis of this study are addressed.

Awareness and identification of climate risks related to biodiversity

Identifying climate impacts and risks is key in motivating adaptation actions to climate change (IPCC, 2014a; Pidgeon, 2012; EEA, 2014; EEA, 2015). It was found in this study that even though there is still variation between sectors, the actors across scales were relatively well aware of the direct climate risks especially when addressing the risks that related to the sector they represented. In addition to the awareness of risks in different sectors, most sectors identified risks concerning biodiversity as well, especially those economic sectors in close connection with natural resources (e.g. agriculture, forestry, water resources and built environment). However, there is still lot of variation seen how sectors connect biodiversity related matters to the activities of different sectors.

Actors also stated at both scales that the trigger to action is often weather related accidents or even disasters making the approach to adaptation less anticipatory which is line with (Keskitalo et al., 2012) who state, that weather related events, such as flooding, droughts and storms provide grounds for adaptation actions in many European countries. The reactive approach to adaptation found also in this study hinders the long-time scale decision making process that is required in e.g. transformational adaptation to cope with the increasing climate risks as stated by EEA (2016) and IPCC (2018b). This reactive approach is particularly tricky for biodiversity, since often the changes in species and habitats are slow and often come visible only after the species is on the verge of extinction. Here, land-use solutions such as extending the conservation network to include habitats not at risk yet from southern parts of Finland also would be important. Putting more emphasis on green infrastructure might also support biodiversity in urban environments.

Another explanation that may affect the identification of the impact chains related to biodiversity could be that the feel of urgency is missing as the impacts of climate change to biodiversity might not be visible straight away, and the direct effects of biodiversity to humans are not always seen. For example, water and electricity-related issues will appear immediately, but changes in the food chain for instance may appear with a delay. Also the current trade and food production systems create a buffer for consumers before the effects of diminishing biodiversity to various goods and products are noticed.

The sectoral divisions and working in sector silos might affect the identification as well since often natural environment and biodiversity related tasks are handled by the environmental administrations and separated from other sector activities. Brown (2018) also states that ecosystem risks to human well-being has remained understated in climate change assessments and sectoral assessments have mostly separated the issues related to natural environment from the resources or services provided to people. Thus climate risks for biodiversity and ecosystems and the consequences of these risks for e.g. agriculture, forestry and water resources have usually not been fully followed through and vice versa.

Furthermore, the anthropogenic view on nature might also contribute to the identification of biodiversity related cross-sectoral impact chains. Nature is often perceived as only having instrumental value instead of respecting its intrinsic value as Taylor (1981) has stated, and this still current paradigm might hinder the observations that changes in the natural environment do not impact only on biodiversity and ecosystems but also ultimately on humans as well as they provide essential services for all life. The interviewees in this study also often treated the matters concerning nature conservation and the exploitation of natural resources separately and the benefit of ecosystems was often perceived by only providing goods and services for different sectors. The intrinsic value of nature was very seldom addressed.

According to Brown (2018), current knowledge of indirect risks remains an important barrier to further development of cross-sectoral adaptation policy. It is also clear from this research that the indirect risks and cross-sectoral perspectives have only recently become on the agenda of climate risk assessment and management and their identification remains somewhat challenging. This was seen especially in the stakeholder workshops, were the actors usually referred to direct impacts and risks of the sector they represented. However, even though the research needs on indirect, cross-sectoral risks and transnational effects is only quite recently paid attention to

(Benzie et al., 2019; Brown, 2018; Tuomenvirta et al., 2018), indirect climate risks were still identified relatively well in the focus-group interviews with administrations. This might be due to the well-functioning coordination leading to effective knowledge and information sharing between administrations pointed out by public officials in many focus-group interviews. This also implies that there is transparency between administrations since Finland's open administrative culture and general atmosphere of trust was often seen as an asset. However, there are still information gaps in communicating cross-sectoral climate risks to stakeholders.

One way to communicate and demonstrate the value of biodiversity to different economic sectors could be through examples. For instance, the interviewees mentioned the blue mussel as being a species that has important cross-sectoral impact chains and both ecological and economic value. The disappearance of this species can have many knock on effects as well as economic effects, as the mussel cleans the water and impacts could be significant if this species suffers. Similar identification of some key species might help to make cross-sectoral aspects related to biodiversity more tangible to different sectors. Furthermore, as IPBES (2018) states, biodiversity and ecosystem services are the foundation of human well-being. These natural processes provide food, raw materials, clean water and air, and other basic conditions for life and are critical for sustaining livelihoods. It would be essential to further emphasise their importance to human systems and demonstrate their linkages to everyday actions of citizens. Even though investing in the provision of ecosystem services might generate costs short-term, there would likely be long-term economic and human well-being benefits as Braat & de Groot (2012) states. Furthermore, more sustainable policies could be actualised through the ecosystem services concept as stated by Bouwma et al (2018).

Another explanation that might hinder the identification of indirect risks and cross-sectoral impact chains is the inconsistency in the used terminology. Even though indirect risks were identified in almost all analysed sectors, the terminology the actors used is not consistent (indirect, cross-cutting, cross-sectoral and interdependent). The terms 'impact' and 'risk' were also used interchangeably. Moreover, in the focus-group interviews, issues related to transnational impacts were raised to some extent, but the term was also frequently used when talking about indirect, cross-sectoral impact chains and risks transmitted from other sectors

within national borders[22]. The lack of consistency in terminology when referring to climate risks might hinder addressing the issues relevant for climate risk assessment and management as it may not be certain what aspect is being referred to. This inconsistency relating to climate impact and risk terminology is also identified by (Benzie et al., 2019) and (Hedlund et al., 2018) when referring to transnational impacts. There is a number of different terms (e.g. spillover effects, indirect climate impacts, traded risk, international effects, systemic risks etc.) describing the transnational phenomenon (Hedlund et al., 2018), and some of these terms overlap with the indirect, cross-sectoral dimension of impacts and risks within national borders. Benzie et al. (2019) suggest that one helpful way forward to support EU level risk assessment would be to develop a consistent typology and language with which to describe the international dimension of climate risk. Developing more unambiguous terminology relating to indirect and cross-sectoral impacts and risks within national borders could also help in their further identification.

Coordination across sectors and scales

Coordination is key in building the society's adaptive capacity and in integrating and mainstreaming adaptation into the planning and activities of various sectors. Both horizontal and vertical coordination are needed (Christensen & Lægreid, 2019; Sanderson et al., 2018; EEA, 2014), and these mechanisms are essential in adaptation activities and biodiversity related issues in Finland as well. However, coordination between actors is one of the greatest challenges in order to achieve cost-effective adaptation (European Commission, 2013; Sanderson et al., 2018). Some of the challenges for both horizontal and vertical coordination of knowledge and information exchange, coordination and engagement of stakeholders, and assignment of responsibilities identified by Sanderson et al. (2018) and Christensen & Lægreid (2019) were also found in this study. Furthermore, conflicting interests and values related to biodiversity was a recurring theme in this study and these conflicts might hinder taking biodiversity related adaptation measures into account in policy making. On the other hand, pointing out conflicting interests implies that there is transparency and open dialogue across administrations and that these matters can be discussed between actors and sectors.

[22] Here, a translation aspect should be raised: the term "heijastevaikutus" is used when referring to transboundary impacts in Finnish, and the term does not directly indicate the international aspect of an impact. This might cause confusion among actors since it could also be interpreted as being a cross-sectoral impact or effect within national borders.

In general it was found, that the need for coordination in adaptation is recognised but systematic planning and implementation of coordination activities is missing. There are also challenges in coordination of actors across scales. For instance, the engagement of stakeholders was a challenge encountered in the stakeholders workshops, as the number of participants varied with region and the overall turn up in the meetings was not very high (Annex 2). Furthermore, in the administration interviews and stakeholder workshops, the general view was that in some sectors there is more coordination than in others. For instance, both horizontal and vertical coordination in water resources management was seen generally strong whereas challenges in coordination were found in biodiversity related adaptation actions.

However, there was a contradiction between how the administrations in focus-group interviews saw horizontal coordination in Finland in general and in adaptation. Many administrative officials stated that horizontal coordination between ministries is an asset and the boundaries for collaboration were seen as being low. This is not really seen in adaptation related actions. For instance, the administrative officials were often not fully aware of adaptation measures conducted in other sectors. Moreover, both on the administrative level interviews and in the stakeholder workshops, the NAP was relatively poorly known. The NAP is from 2014, but there are still gaps on a governmental level in acknowledging its existence. This might be due to mitigation currently overshadowing adaptation actions, or that the NAP has not been promoted enough to relevant decision-makers in the administrations. It was also stated on a few occasions, that in order to implement adaptation actions, there should be more legislative force steered for the implementation. This could indeed be relevant for adaptation measures and might to some extent solve some implementation barriers.

Furthermore, the fragmentation of data and where to find information was also a key topic that rose from both the focus-group interviews and the stakeholder workshops. Interestingly though, there actually already are forums existing in Finland gathering relevant information on various aspects of climate change such as the Climateguide.fi[23] which addresses impacts, mitigation and adaptation of climate change and shares municipality-related knowledge on climate change. However, that portal is aimed not only to decision-makers but is also used for educational

[23] The Climateguide.fi portal: https://ilmasto-opas.fi/en/

purposes, and is run on project-based funding. One solution here could be to establish an adaptation only portal based on policy support aimed to decision-makers such as those in Sweden[24], Denmark[25] and Norway[26].

Furthermore, to improve adaptive capacity and resilience, adaptation measures need to consider local conditions as stated by Sanderson et al. (2018). Although adaptation strategies and plans are often first adopted at national level, their implementation requires strong involvement at regional and local levels (Christensen & Lægreid, 2019; Sanderson et al., 2018). Adaptation is also recognised as being a context specific issue where no one measure can meet the regional and local needs (Adger et al., 2005; IPCC, 2014a). The local and regional perspectives were also emphasised especially among the stakeholders in all climate risk management and adaptation issues. The stakeholders often stated that the local measures should be further considered and regional and local adaptation plans were called for. However, the issue of who should be responsible for such actions remained mostly unsolved even though the county, especially after the regional reform, was suggested to be the actor responsible for overall coordination in adaptation on a more regional level. Additionally, the stakeholders also called for more vertical coordination mechanisms and sectoral steering from the ministries responsible for the sectors.

The regional and local adaptation perspective could indeed be addressed by the county providing also a better chance for a multisector approach as many interviewees stated. However, national adaptation policy measures are still important to steer the overall national adaptation goals and policy objectives as also identified by e.g. UNFCCC (2018). Therefore, further governmental steering is also required. Moreover, appointing the county responsible for the coordination of adaptation does not automatically solve the issue of working in sector silos, but dialogue within the county across sectors are still required.

For biodiversity, these coordination challenges become vital. In addition to the direct risks from climate change, biodiversity comes further exposed to risks also emerging from other sectors as it is not considered in decision-making in different sectors and there is not sufficient

[24] Swedish Portal for Climate Change adaptation: http://www.klimatanpassning.se/en

[25] Climate Change Adaptation in Denmark: https://en.klimatilpasning.dk/

[26] The Norwegian Climate Change Adaptation Portal: http://www.klimatilpasning.no/infosider/english/

coordination across sectors in biodiversity related matters. Conflicting interests and institutional factors, such as legal frameworks, are also one key challenge for coordination (EEA, 2014, 2015; Sanderson et al., 2018). These challenges also emerged especially from the focus-group interviews with administrations and some of the conflicting values and interests pointed out in this study might hinder the actor's willingness to act in a way that biodiversity related matters are also better followed through. For instance, the pesticide bans such as the glyphosate ban pointed out in the transport sector is good for sustaining biodiversity and reducing chemicals in the soil but at the same time, it increases the amount of work in maintaining, for instance, the train tracks. It may also become a transport safety issue as stated by the interviewees. These conflicting interests might hinder the overall compliance with these regulations and in turn affect negatively to sustaining biodiversity.

Like climate change, biodiversity issues should be a cross-cutting theme at all scales of decision-making to be able to reduce the climate risks to biodiversity and ecosystems and to humans as well. Furthermore, mainstreaming biodiversity aspects to all economic sectors is essential to conserve biodiversity as also pointed out by Karlsson-Vinkhuyzen et al. (2017). The importance of considering biodiversity issues in decision-making also emerged from this study. For instance, when it comes to managing climate risks related to biodiversity, both the administrations and the stakeholders identified land-use changes and building wetlands as most important adaptation measures. Implementing more nature-based solutions and enhancing ecosystem-based adaptation were emphasised especially in the built environment, water resources management, natural resources and biodiversity sectors. This nature-based approach to adaptation could indeed be a measure that could combine adaptation and help to sustain biodiversity. Wamsler & Pauleit (2016) and Brown (2018) also state using ecosystem-based adaptation (i.e. the use of ecosystem services to adapt to climate change) can enhance resilience both in natural and human systems and can buffer risks as well as sustain ecosystem services.

Mainstreaming ecosystem-based approach into municipal planning to foster sustainable transformation is receiving increasing interest from both academic and governmental bodies (Wamsler & Pauleit, 2016). There is also ongoing research in Finland about how to utilize these

nature-based solutions in adaptation actions[27]. However, cross-sectoral coordination is required in effective implementation of ecosystem-based approach (Brown, 2018), and ways forward can be challenging if cross-sectoral coordination regarding biodiversity and nature conservation is not actualised. Furthermore, according to Gupta & Grijp (2010), one of the main challenges in mainstreaming is the lack of coherence or compatibility among policies. The conflicting policies and interests also found in this study might hinder mainstreaming biodiversity as these different policies and agreements may not sufficiently consider sustaining and conserving biodiversity. Moreover, the engagement and commitment of regional and local level actors is essential in mainstreaming ecosystem-based adaptation as stated by e.g. Wamsler & Pauleit (2016). Thus it is important to make sure that different factors related to coordination, such as knowledge and information exchange and assignment of responsibilities, are actualised across scales and actors in effective implementation of ecosystem-based adaptation.

The international dimension of climate impacts and risks

In addition to the importance of acknowledging cross-sectoral risks and coordination needs within national borders, the international repercussions and impact chains can bring about changes to all sectors that should be further considered in national adaptation policies as well. In general, the direct impacts and risks of climate change regarding biodiversity are rather well recognized in the sectors, and indirect risks are also being increasingly paid attention to but the transnational impacts are still relatively poorly known. Even though the focus in this study is on the national level, the transnational dimension is receiving growing attention in the climate field as climate change impacts in one area of the world are likely to have repercussions elsewhere. This strongly implies a need for enhanced international cooperation for adaptation. The importance of this dimension rises from the material used in this study as well. Climate factors can affect political risks around the world, and because of the nature of a globalised world, Finland can have a very notable transnational impact from events occurring outside national borders.

[27] For example, there is a currently ongoing research project (TASAPELI in Finnish) in Finland that aims to seek effective nature-based solutions as tools for adapting to climate change at regional and local level.

According to Hedlund et al. (2018) the transnational dimension of climate risk is rarely acknowledged in climate change impact and vulnerability assessments, and consequently receives very little attention in adaptation planning at any scale. The authors also see a key limitation of the widespread view that mitigation is global while adaptation is local, and even though it is crucial to ensure adaptation in the places that are directly affected by climate change, it is also essential to recognize and address cross-border risks (Hedlund et al., 2018). However, this risk dimension of climate change is difficult to assess and manage as well as it is challenging to foresee exposure to risks since they are linked to complex impact chains (Benzie et al., 2019; Gregow et al., 2016; Tuomenvirta et al., 2018).

The transnational dimension is present in issues related to biodiversity as well since biodiversity related matters do not obey national, or sectoral, borders. The cross-border collaboration related to biodiversity is also paid attention to in Finland. For example, there are coordination efforts with other Nordic countries and Russia, such as the already mentioned collaboration project Green Belt of Fennoscandia. Furthermore, an important linkage is with international collaboration and international agreements related to biodiversity. Changes in legislation at EU level and international agreements are also causing changes in decision-making related to adaptation and biodiversity in Finland. However, many interviewees across sectors also pointed out, that the national and subnational agreements should take better into account the global agreements related to biodiversity and nature conservation, also when it comes to ocean conservation. According to the focus-group interviews, many national and international agreements have not sufficiently considered climate change as a driver in biodiversity related issues and more attention should be paid to link climate change into biodiversity agreements at all levels and in e.g. EU directives.

Further research needs and analysis reflections

As stated by Tuomenvirta et al. (2018), the impact chains in the nature and nature-dependent sectors are very complex and largely still unknown. The indirect risk dimension of climate change is also just beginning to receive more attention in the climate field and more research on the topic should be conducted. The material and methods applied in this study are not sufficient to comprehensively address the complex impact chains related to indirect climate risks and biodiversity. Further research is needed on identifying cross-sectoral impact chains and indirect risks related to biodiversity and ecosystem services, and also how the complex impact chains could be made more visible and tangible across sectors.

Before concluding this study, a few remarks concerning the results and discussion parts of the thesis are made. It should be noted, that in most of the focus-group interviews and workshops, the interviewees and different sector representatives were not specifically asked about risks to biodiversity but rather they could raise the issues concerning it if they found it relevant. This might affect the identification of the indirect risks related to biodiversity, and different results could have been achieved if the questions would have been directed to relate only to biodiversity. As it was stated in section 3.4, I could not affect the choice of questions or the selection of sectors or interviewees during this study. However, the focus-group interview and workshop settings provided the participants a chance to discuss the topics they found relevant, and biodiversity and natural environment related topics were among the most addressed matters. This implies that there is a need for considering it further in climate policies and decision-making processes across sectors and scales.

Furthermore, NVivo proved to be a useful tool in transcribing and analysing the material. For instance, the coding scheme can be modified at any time rather easily in NVivo. Also double-coding a certain reference under the same node is not possible, since the program automatically excludes any double counts. However, even though significant overlaps were tried to be avoided, some overlapping might have occurred nonetheless in interpreting the data and this might be reflected in this study.

7 Conclusion

The objective of this study was to analyse the awareness of climate risks and identify some of the direct and indirect climate risks and impact chains concerning biodiversity in Finland. The aim was also to analyse how coordination between actors and administration levels to manage these risks is working in biodiversity related matters.

It was found that even though the actors are relatively well aware of climate risks in general, the uncertainties about the risks and their magnitude to different sectors make identification challenging. There is also a need to further raise awareness on both direct and indirect weather and climate related impacts and risks, without forgetting the international dimension of climate impacts and risks. The actors in different sectors also still focus on direct impacts and risks in the sector they are representing and identifying let alone considering these indirect risks in decision-making is still in its infancy. This is especially harmful for biodiversity because it is a theme to which sectoral, and national, boundaries might be difficult to apply. Therefore, various economic sectors should consider biodiversity in sectoral plans and programmes as well as find synergies with adaptation actions.

As the risks from climate change are gradually expected to increase and further indirect and direct risks to all natural and human systems are likely to occur, new measures linking adaptation and the conservation of biodiversity to sustain provision of nature's contributions to humans are key. This requires connecting biodiversity and climate change related matters into all sectoral policies at all scales. Furthermore, structural changes are needed as well since the challenges societies are facing with various aspects of climate change can no longer be actualised through gradual development. Here, coordination between actors and sectors across scales is essential in order to successfully implement adaptation measures that also contribute to sustaining biodiversity in the everyday planning and activities of various sectors. Cross-sectoral coordination also enables sharing good practices and lessons learnt among different actors. There are already existing opportunities in cross-sectoral coordination, but the coordination challenges identified hinder further implementation of adaptation activities.

While NAPs are key to coordinate adaptation on a national scale, most successful adaptation efforts are likely to be local as communities and other subnational actors are responding to locally emerging climate risks and thus are essential for implementation. This calls for regional

and local adaptation plans as well. However, local actors will increasingly need external support because various dimensions of climate risks can overwhelm local adaptive capacity. Therefore, it is important for the national and even international community to identify the most effective means to support local adaptation, and to find synergies in designing and implementing adaptation activities and in sustaining biodiversity.

Finally, biodiversity and ecosystems are the foundations of human well-being as they provide services, such as food, clean water and air, and cultural and recreational experiences of which humans heavily depend on. The changes in them might influence drastically to all socioeconomic activities leading to severe cultural, economic and social implications. It is essential to emphasise both to decision-makers and to the public the importance of sustaining biodiversity and how crucial the well-being of ecosystems is to humans as well. It would also be equally important to try to make the complex impact chains regarding biodiversity more visible both to decision-makers and to the public so that the linkages and repercussions of everyday actions from e.g. food production, energy industry and housing to biodiversity could be more tangible.

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Annexes

Annex 1. Administration interviews

Focus-group interview guide with administrations. *Note: Addressed key topics and questions were selected by the mid-term evaluation team and were based on a similar framework presented at each meeting. Questions may have varied depending on the sector in question, interview flow and other points of enquiry.*

Addressed topics	**Questions (English / Finnish)**
Identified weather and climate risks to the sector in question. *(Discussion based on preparatory material from the 2018 National Climate Risk Assessment)*	• Are risks identified in the sector? What about outside the administration? / Tunnistetaanko riskit toimialalla? Entä hallinnon ulkopuolella? • Do you collaborate with other sectors? / Tehdäänkö yhteistyötä muiden toimialojen kanssa?
Objectives, measures and implementation of the adaptation plan / overall progress in adaptation implementation. *(Discussion based on monitoring information of the implementation of the NAP)*	• Are the (identified adaptation) measures sufficient? / Ovatko (tunnistetut sopeutumiseen liittyvät) toimet riittäviä? • How are the transboundary effects and cross-sectoral risks taken into account? / Miten heijastevaikutuksia ja poikkisektoraalisia riskejä on huomioitu? • Why the work has not proceeded (if this was observed)? / Miksi työ ei ole edennyt (jos näin havaittiin)?
Future needs	• Are the actions and contributions sufficient for the identified risks in the sector? / Ovatko toimet ja panokset riittäviä? • What is needed in the future? / Mitä jatkossa? ○ Implementation challenges? / Toimeenpanon

	haasteet? o Additional needs, resources and enabling factors? / Tarvittavat jatkotoimenpiteet, resurssitarpeet ja edellytykset? o Coordination between actors? / Toimijoiden välinen yhteistyö?

Focus-group interviews used in the thesis

Administrative branch and location	**Date**	**Number of attendees***
Built environment, Ministry of the Environment	17.4.2018	3
Water resources management, Ministry of Agriculture and Forestry	17.5.2018	8
Natural resources (agriculture, forestry, fisheries, game and reindeer husbandry), Ministry of Agriculture and Forestry	21.5.2018	11
Energy, Ministry of Economic Affairs and Employment	30.5.2018	5
Transport, Finnish Transport Infrastructure Agency	31.5.2018	8
Biodiversity and the natural environment, Ministry of the Environment	14.9.2018	3
Health, Ministry of Social Affairs and Health	13.11.2018	16**

* The facilitators are excluded from the number of attendees.

** The focus-group interview with health administration was held during another administrative meeting.

Annex 2. Stakeholder workshops

Regional meetings and local themes corresponding to regional characteristics of the area

City and region	Date	Addressed themes	Number of participants* based on interest groups
Joensuu (North Karelia)	28.9.2018	Agriculture and forestry, biodiversity, preparedness and risk management, water resources	Municipality: 7 Research: 4 Third sector: 1 Private sector: 3 *Total:15*
Tampere (Pirkanmaa)	1.10.2018	Transport, built environment, emergency services	Municipality: 9 Research: 1 Third sector: 2 Private sector: 0 *Total:12*
Helsinki (Uusimaa)	2.10.2018	Finance and insurance, social affairs and health, water services and water management, emergency services	Municipality: 12 Research: 2 Third sector: 1 Private sector: 4 *Total:19*
Rovaniemi (Lapland)	10.10.2018	Agriculture and forestry, game and fisheries management, bioeconomy, tourism, administration	Municipality: 6 Research: 6 Third sector: 3 Private sector: 2 *Total: 17*
Vaasa (Ostrobothnia)	31.10.2018	Energy, emergency services	Municipality: 5 Research: 2 Third sector: 1 Private sector: 2 *Total:10*

* The representatives from the organisers (SYKE, Ministry of Agriculture and Forestry and Akordi Oy) are excluded from the overall number of participants.

Questions for the stakeholders (English | Finnish):

- How is your organisation/reference group prepared for climate risks? | Miten oma organisaatiosi/viiteryhmäsi on varautunut ilmastoriskeihin?
- What is the level of knowledge and risk awareness in the organisation? | Millainen on tiedon taso ja riskitietoisuus organisaatiossa?
- Is preparedness part of the organisation's operations? | Onko varautumisesta tullut osa organisaation toimintaa?
- What has changed in practice? State concrete actions. | Mikä on muuttunut käytännössä? Konkreettiset toimet.
- How do you communicate on the subject? | Miten aiheesta viestitään?

Annex 3. Translated quotes

Original (Finnish)	**Translation by the author (English)**	**Focus-group interview, date and thesis page number**
”Sopeutuminen terminä vaikea, sitä ei välttämättä ymmärretä. Mutta jos puhutaan enemmän riskien hallinnasta ja minkälaisia riskejä tarkoitetaan, se avaa asiaa enemmän. Asiat pitäisi tehdä vielä yksinkertaisimmiksi. Tarvitaan ketteryyttä, kun haasteet lisääntyy.”	*“Adaptation as a term is difficult, it may not be understood. But if you talk more about risk management and what the risks mean, it opens up more. Things should be made even simpler. Agility is needed when challenges increase.”*	Natural resources, 21.5.2018, p. 35
“[Riskit] tunnistetaan hyvin, mutta ei käsitellä ilmastonmuutos-käsitteen alla. Säätilaan liittyvät asiat tunnetaan hyvin energiapuolella ja ne [riskit] ovat selkeämpiä energiapuolella.”	*“[The risks] are well identified but are not handled under climate change concept. Weather issues are well known on the energy side and [risks] are clear on the energy side.”*	Energy, 30.5.2018, p. 35
”Vesitaloudessa varautuminen sisään rakennettua, mutta ei käytetä sopeutumisen termiä. Ilmastonmuutos yksi tärkeä tekijä sektorin varautumisessa ja itsestäänselvyys sektorin toimijoille, mutta riittäkö se? Se on vielä epäselvää.”	*“Preparedness in water resource management is built-in, but the term adaptation is not used. Climate change is an important factor in the sector's preparedness and self-evident for the sector, but is it enough? It's still unclear.”*	Water resources management, 17.5.2018, p. 35
”Mennään onnettomuuksien kautta siihen, että jotain tehdään. Tietoisuus lisääntyy usein vasta tätä kautta.”	*“We need to go through the accidents to do something. Consciousness often increases only through this.”*	Energy, 30.5.2018, p. 36
”Sektoreilla on erilaiset mahdollisuudet toteuttaa erilaisia asioita, esim. monimuotoisuus on hirveän paljon kiinni muista sektoreista ja siinä on ristiriitaisia tilanteita, saattaa mennä edut vastakkain ja on paljon haastavampaa, kun taas alueidenkäytössä ymmärretään että ei kannata rakentaa niin, että jäädään tulvan alle.”	*"Sectors have different opportunities to do different things, for example, biodiversity is extremely dependent on decisions in other sectors and there are conflicting situations, there may be contradictory goals and it is much more challenging, while in land use and regional planning it is not worth building so that we will stay under the flood."*	Built environment, 17.4.2018, p. 44

”Ekosysteemipalvelut kannattaa huomioida laajemmin myös sisävesien ja merien puolella. Intensiivistä tutkimusta käynnissä meillä ja muualla maailmassa. Sieltä saa selkeitä numeroita talousvaikutuksiin, miten esim. sinisimpukan häviäminen vaikuttaa. Tärkeitä, poikkisektoraalisia asioita ja vaikutusketjuja.”	*“Ecosystem services should also be considered more extensively on inland waterways and seas. Intensive research is ongoing here and in the rest of the world. From there, you get clear numbers of the economic effects of how the disappearance of mussels, for example, affects. Important cross-sectoral issues and impact chains.”*	Water resources management, 17.5.2018, p. 50
”Paikallinen ja pienen alueen kysymys onkin valtakunnallinen […] vesiteeman ja jään kytkökset luonnon monimuotoisuuteen, esim. Saimaan norppa ja itämeren norppa ovat häipymässä. Myös teerillä soidinmenoja jäällä. Esim. nämä ja muut lajit vaarassa, jotka ovat jäästä ainakin osittain riippuvaisia.”	*“A local and small area issue can become national and global [...] and the link between water theme and ice to biodiversity, for instance, the Saimaa seal and the Baltic Sea seal are fading. Also the black grouse has mating displays on ice. For example, these and other species dependent on ice are at risk to disappear.”*	Water resources management, 17.5.2018, p. 45
”Jos mietitään suojelualueiden näkökulmasta ja ympäröivää maankäyttöä vaikkapa metsien ja metsätalouden näkökulmasta, niihin tulee todennäköisesti myös isoja muutoksia ilmastonmuutoksen seurauksena, esimerkiksi mitä lajeja kasvatetaan, ilmastonmuutoksen aiheuttamat muutokset muussa maankäytössä heijastuu myös monimuotoisuuden turvaamiseen.”	*“If we consider protected areas and the surrounding land use, for example, from a forest and forestry perspective, there are likely to be major changes as a result of climate change, for example, what species are grown. Climate change impacts for land use have also implications for safeguarding biodiversity.”*	Biodiversity sector, 14.9.2018, p. 46
”Ympäristöhallinto vielä aika alkutekijöissään asiaan liittyen, on vasta tullut sopeutumisohjelmaan toimenpiteitä, ne vaikuttavat siihen, miten keskustellaan muiden toimialojen kanssa, mitä tiedetään ja mikä on valmiustaso.”	*“Environmental administration is still in its infancy related to this, measures have been only recently added to the adaptation program, these [measures] affects how we discuss [the matters] with other sectors, what is known and what is the level of preparedness.”*	Biodiversity sector, 14.9.2018, p. 53

”Odotetaan, milloin ilmastopaneeli tarttuu monimuotoisuuteen liittyviin kysymyksiin. IPBES ja IPCC olisi hyvä saada keskustelemaan keskenään.”	*“We are waiting for the [Finnish] Climate Panel to grasp the biodiversity issues. It would be good to have IPBES and IPCC discuss with each other as well.”*	Biodiversity sector, 14.9.2018, p. 54
”Yleisesti biodiversiteettiin liittyvät asiat voivat olla vastakkaisia […] esim. puuston poisto vaikuttaa hiilinieluun sekä biodiversitettiin ja mahdollisesti vieraslajeihin.”	*“In general, biodiversity issues can be contradictory […] e.g. removal of trees affects the carbon sink, biodiversity and possibly alien species.”*	Transport, 31.5.2018, p. 55